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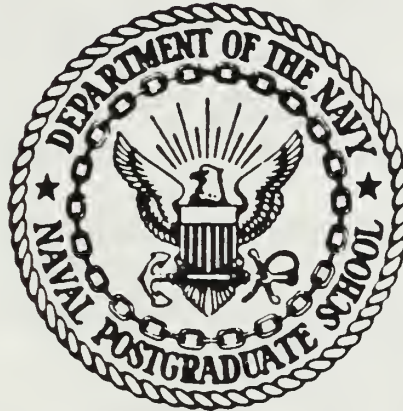
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THESIS

OPTIMIZING HF ANTENNA SYSTEMS
ON THE DOLPHIN AND SEA HAWK HELICOPTERS

by

James B. Crawford

September 1987

Thesis Advisor

R.W. Adler

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Optimizing HF Antenna Systems
on the Dolphin and Sea Hawk Helicopters

by

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Lieutenant Commander, United States Coast Guard
B.S., United States Coast Guard Academy, 1974

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN AERONAUTICAL ENGINEERING

from the

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September 1987

ABSTRACT

Making an aircraft available and modifying it to test various antenna systems and configurations is extremely costly. The computer model is an excellent alternative means of analyzing antenna systems for optimum communication system performance. In this study electromagnetic "wire grid" computer models of two helicopters and eight HF antenna configurations are developed using Interactive Graphics Utility for Automated NEC Analysis (IGUANA). Numerical Electromagnetics Code (NEC) is used to obtain radiation patterns, and the Advanced Prophet program is used to develop the criteria for judging system effectiveness. These computer results compare favorably with test range data, showing great savings of cost. They provide the additional advantage of showing radiation patterns at an elevated angle for skywave propagation analysis (patterns which cannot be obtained on an antenna test range).

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I. INTRODUCTION

A. NEED FOR THE STUDY

The Coast Guard relies heavily on helicopters to perform its primary missions of enforcement of laws & treaties, search and rescue, aids to navigation, and maritime defense. Two types of helicopters are used in the Coast Guard. The medium-range recovery (MRR) helicopter is the HH-3F Pelican which will be replaced shortly by the HH-60J Sea Hawk. The transition from the HH-52A Guardian to the HH-65A Dolphin is almost complete. The Dolphin is the Coast Guard's short-range recovery (SRR) helicopter. In executing their assigned missions both the MRR and SRR routinely operate from the coast line out to 200 nautical miles off shore and remain below 1000 feet for most of the mission. It is essential for the helicopters to maintain effective communications with a Coast Guard communication station to exchange operational information and receive direction as well as for flight following.

B. STATEMENT OF THE PROBLEM

The Dolphin was designed to use a Rockwell-Collins 718U-5 HF radio transceiver and a long-wire antenna to provide reliable two-way voice communications at ranges

of up to 200 nautical miles. Figure 1, taken from the HH-65A flight handbook, illustrates how the long-wire antenna runs along the tail boom and up the vertical tail on the starboard side, through a non-metallic transition tube, and doubles back along the port side of the helicopter. During development flight tests the operational performance of this system was found to be marginal at best. Shortly after accepting the Dolphin for operational use several aircraft experienced structural failures of the long-wire resulting in wire ingestion into the fenestron. Consequently, the long-wire was shortened to exclude the portion along the vertical tail. This modified antenna exacerbated the performance problems of the Dolphin's HF system.

The MRR replacement helicopter, the Sea Hawk, was reported to have similarly poor HF operational performance and the Navy has zeroed in on the long-wire antenna as the chief cause of the problem. [Ref. 1]

C. PREVIOUS WORK

Tests were recently conducted at the Naval Air Test Center, Naval Air Station, Patuxent River, Maryland, to determine the operating performance of the HF long-wire antenna installations on both the Dolphin and the Sea Hawk. Similar tests were conducted with a Rockwell-Collins 437R-2 tuned HF monopole antenna system installed

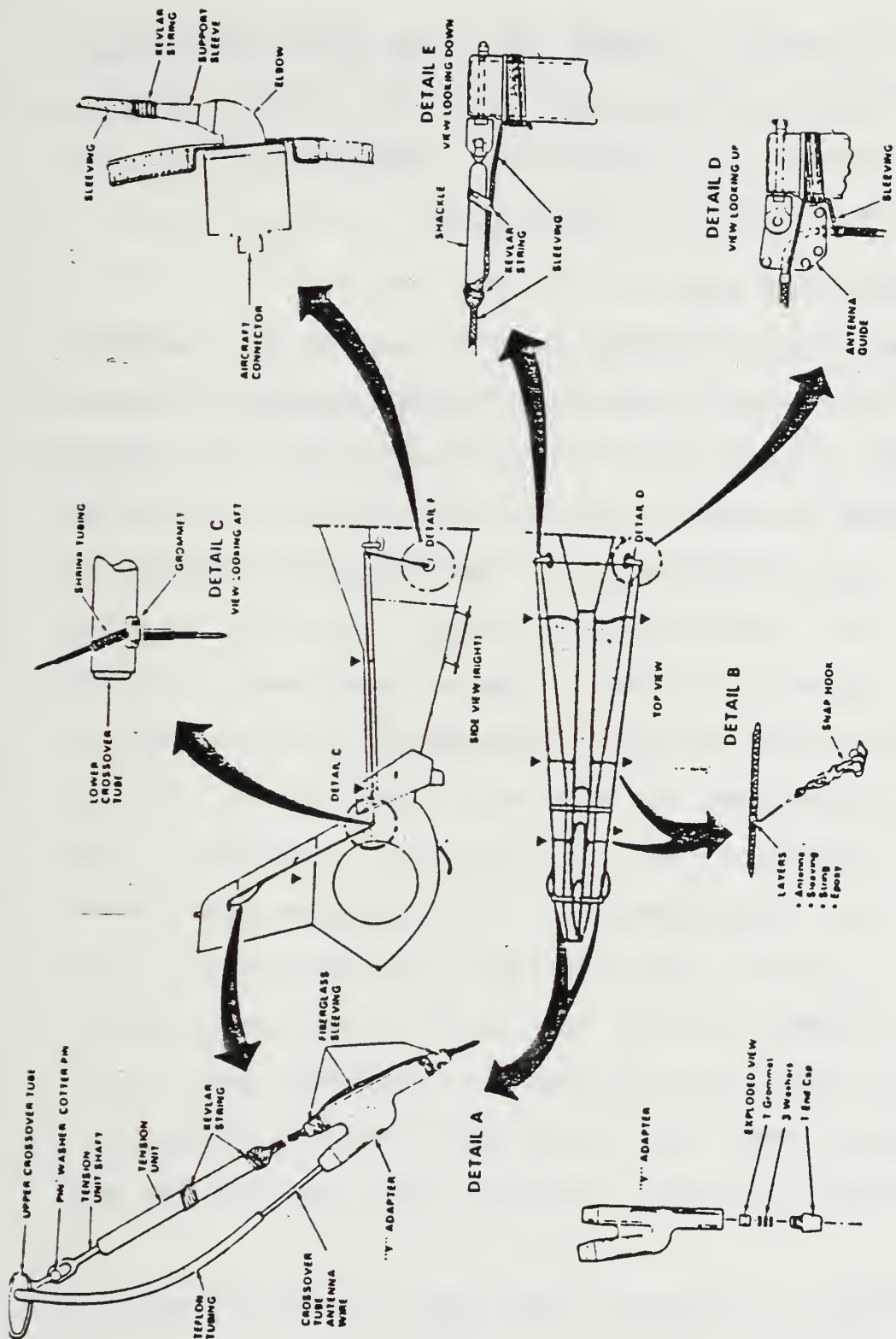


Figure 1 Dolphin Long-wire Antenna Configuration.

on each helicopter. Comparison of radiation patterns in the horizontal plane showed that the tuned monopole system improved HF performance, particularly in the vertical polarization. [Refs. 1, 2]

D. SCOPE OF THE THESIS

Actual aircraft modification to test various antenna systems and configurations has proved extremely costly and time consuming. In this thesis study computer modeling was used as an alternative method for testing HF antenna system performance. The Interactive Graphics Utility for Automated NEC Analysis (IGUANA) computer program, prepared for NOSC by System Development Corporation, was used to develop electromagnetic computer models for the Dolphin and Sea Hawk helicopters as well as for various configurations of long-wire, monopole, and shorted-loop type antennas. These computer models were used as input for the Numerical Electromagnetics Code (NEC), a computer program developed at Lawrence Livermore Laboratory under the sponsorship of the Naval Ocean Systems Center (NOSC) and the Air Force Weapons Laboratory. Radiation patterns were obtained as the output of the NEC runs.

Typically, an antenna range can conveniently measure radiation patterns only in a plane which is nearly horizontal. Since ground waves over the ocean rarely

propagate more than 100 to 150 nautical miles at best, communication in the HF range frequently requires the use of sky wave propagation. It would be helpful to be able to obtain radiation patterns at any angle above the horizon. The engineer would then have more complete information on which to base a comparative decision on the ground wave/sky wave performance of various antenna systems. The computer models developed in this thesis, combined with the NEC code provide a convenient mechanism to obtain radiation patterns in any direction.

II. SKY WAVE PROPAGATION

Sky wave propagation occurs when a signal is "reflected" or bent in the ionosphere.

A. NATURE OF THE IONOSPHERE

The ionosphere is an ionized region in the upper atmosphere extending from about 60 to 300 kilometers. The portion of the ionosphere which is used for HF propagation is broken down into three regions -- D, E, and F -- with electron density increasing and neutral atmospheric constituents decreasing with altitude. The amount of bending or reflection experienced by a signal in the ionized layers is dependent on frequency. Higher frequency signals are bent to a lesser degree than lower frequency signals and therefore penetrate farther into the ionosphere. There is a certain critical frequency which, if exceeded, allows the signal to escape into space before being sufficiently bent to return to earth. So, for effective sky wave communications, a frequency must be utilized which is lower than the critical frequency.

On the other hand, losses are greater at the lower frequencies due to energy absorption as a result of

setting the ionized particles into motion. Because of the high ratio of neutral to ion particles in the lower ionosphere, an electron passing through this region is more likely to collide with a neutral particle and consequently be unable to re-couple all of its energy back into the wave. By completing its reflection in the lower levels of the ionosphere, the lower frequency signal spends comparatively more time in a region with high neutral particle densities. Higher frequency signals pass more quickly through these high-loss regions and are turned back toward the earth with less overall losses. [Refs. 3, 4]

B. PROPAGATION VIA THE IONOSPHERE

A compromise must be established where the frequency is low enough to permit the signal to be returned to earth but high enough so that all useful energy is not absorbed enroute to the receiving station. The lowest usable frequency is termed the LUF, while the maximum usable frequency is termed the MUF. The best compromise frequency, as described above, is termed the FOT, or Frequency of Optimum Transmission. The FOT is considered to be approximately 80% of the MUF. In fact, deviation away from the FOT results in extra losses which significantly reduce system performance when communicating via sky wave. John Brune of the Army's NOE

Communications Branch at Ft. Monmouth, NJ, compiled data which shows that deviating ± 1.5 MHz from FOT in the early morning hours produces 20 dB "extra expected" loss. The mid-day period is only slightly more forgiving where a deviation of ± 2 MHz produces the extra 20 dB loss. A loss of 20 dB equates to one one-hundredth effectiveness. Mr. Brune points out correctly that for a successful sky wave communications link it is advisable to give more attention to choice of frequency rather than increase of transmitter power. [Ref. 5]

The elevation angle of the transmitted signal is another important factor in sky wave propagation. As shown in Figure 2, transmitted rays entering the ionized region at angles above the critical angle for that frequency are not bent enough to be returned to earth. Rays entering at angles below the critical angle are returned to earth at increasingly greater distances as the angle approaches the horizontal. It is clear that there is a certain distance along the earth's surface where little or no signal energy will be found. This area, called the skip zone, is too far away from the transmitter for effective ground wave coverage, and too close for sky wave coverage.

It seems at first glance that the skip zone would be easy to predict. The critical ray angle for a given

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DATE: 1/1/86 TIME: 18:00 UT ATMOSPHERIC NOISE: YES
 PREP: 9.0 SSN: 59.0 KP: 1.0 MAN-MADE NOISE: SH SNR REQD: 12.0 DB
 QMIR: HELO2 36-0-0 N 72-30-0 W ANT: 0 0 WOMNIX PWR: 100.00
 QCUR: NEOLK 36-40-12 N 76-31-48 W ANT: 182 0 WOMNIX RANGE: 198.9 NMI
 IONOSPHERE: FOF2= 3.9 MHZ FOF1= 4.2 MHZ FOF3= 8.6
 HMF2= 341. KM VME2=119.3 KM

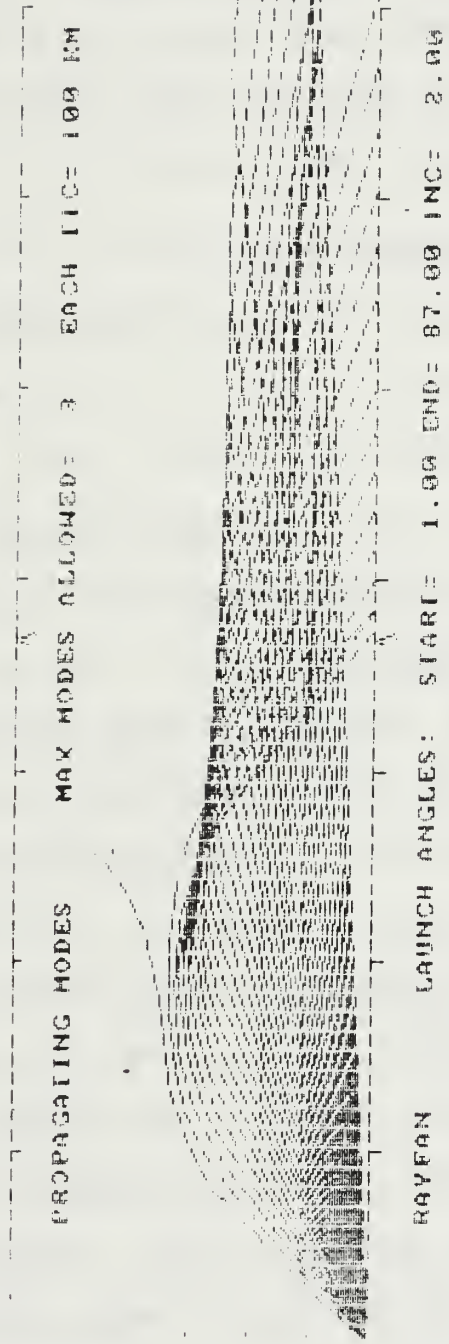


Figure 2 Advanced Prophet Critical Ray Angle.

frequency, however, is a complicated function of ionization density and layer height. The ionization of the atmosphere is believed to be caused by ultraviolet radiation from the sun. The degree of ionization of a layer is dependent upon time of day, season, and sun spot activity. [Refs. 3,4,6]

c. COMPUTER SIMULATION

Several computer programs are available to predict propagation via the ionosphere but Advanced Prophet, distributed by Naval Ocean Systems Center, is used herein. It is compatible with the Coast Guard Standard Terminal and provides all the required features necessary for this study.

The Advanced Prophet program was used in a scenario where a ground station at Norfolk, Virginia, was communicating with four helicopters engaged in typical Coast Guard missions. The range to helo 1 was 100 nautical miles (nm) and to helo 2 was 200 nm. Helo 3 was introduced only once to compare its horizontally polarized signal's ground wave range with that of the vertically polarized signal of helo 2. Helo 4 had the closest range at 50 nm. The helicopters were operated at 1000 feet above the ocean, the wind was programmed to be 25 knots, and the sun spot number was set at an average value of 50. The noise models were engaged and the

transmission mode was selected to be single side-band. The ground station used a vertically polarized antenna while the helos (except helo 3) were assumed to radiate isotropic signals. Summer and winter seasons were investigated as well as daytime and nighttime ionospheric conditions. The complete results of the simulation have been included in Appendix B, and certain figures from the study have been used to illustrate points in this section.

D. EFFECTIVE COMMUNICATION

The goal of effective communication from zero to 200 nm range is met by eliminating transmitting station's skip zone (Figure 3). This may be accomplished by increasing the area of ground wave coverage and by increasing the critical ray angle to bring the limit of sky wave coverage closer to the transmitter.

As illustrated in Figures 4 and 5 and explained in Reference 8, page 9-4, effective ground wave propagation over the ocean beyond 10 nm range is made possible by use of vertically polarized signals. An efficient Coast Guard helicopter's antenna system should produce a high gain, uniformly distributed, vertically polarized radiation pattern in the horizontal plane. Figure 4 shows that frequency selection is also very important in

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 GWR CONFERENCE 1 DATE: 1 1 86 TIME: 05:00 UT

LONGITUDE FREQUENCY: 3.12 MHz

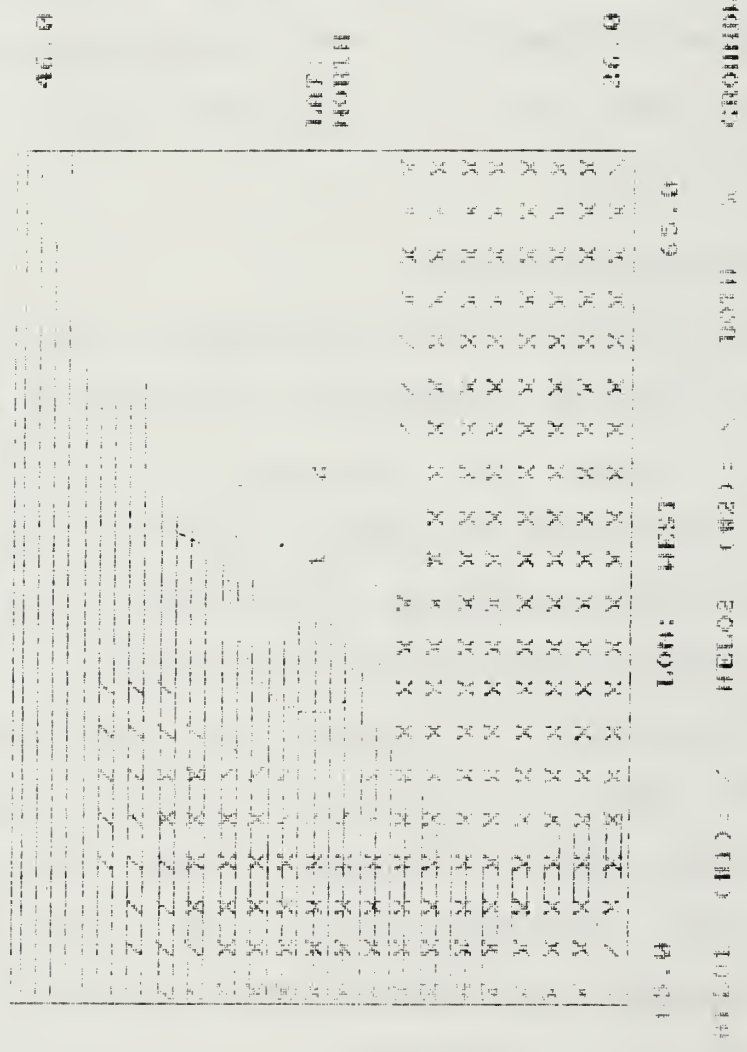


Figure 3 Advanced Prophet Area Coverage.

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GROUNDWAVE ANALYSIS FOR DATE: 7/ 1/86 TIME: 18:00 UT
 XMTR: HELO2 POLARIZATION: V POWER: 100.000 WATTS
 RCVR: NEOLK FREQUENCY: 5.696 MHZ RANGE: 198.9 NMI
 ANTENNA HEIGHT XMTR: 500.0 FEET RCVR: .8 FEET
 TERRAIN: SE COVER: // WIND: 25.0 KNOTS ATMOSPHERIC NOISE: YES
 DIELECTRIC: 81.0 SURFACE CONDUCTIVITY: .40E+01 MUO/M
 READ SNR: 12.0 DB BANDWIDTH: 2.800 KHZ MANMADE NOISE: SH

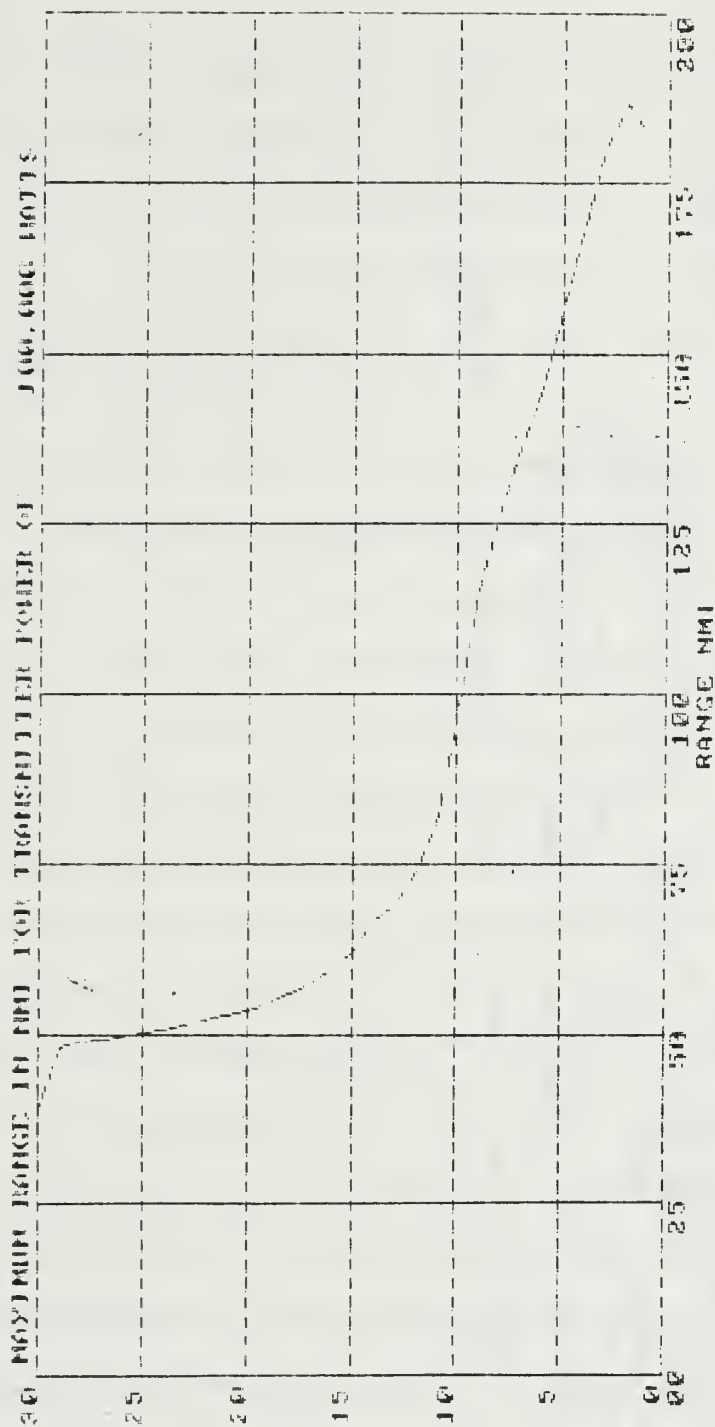


Figure 4 Ground Wave Range vs. Frequency,
 Vertically Polarized Signal.

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GROUNDWAVE ANALYSIS FOR DATE: 7/1/86 TIME: 18:00 UT
 XMITR: HEL03 POLARIZATION: H POWER: 100.000 WATTS
 RCVR: NEOLK FREQUENCY: 5.696 MHZ RANGE: 198.9 NMI
 ANTENNA HEIGHT XMITR: 500.0 FEET RCVR: .0 FEET
 TERRAIN: SE COVER: // WIND: 25.0 KNOTS ATMOSPHERIC NOISE: YES
 DIELECTRIC: 81.0 SURFACE CONDUCTIVITY: .000101 MUO/M
 REQD SNR: 12.0 DB BANDWIDTH: 2.800 KHZ MANMADE NOISE: SH

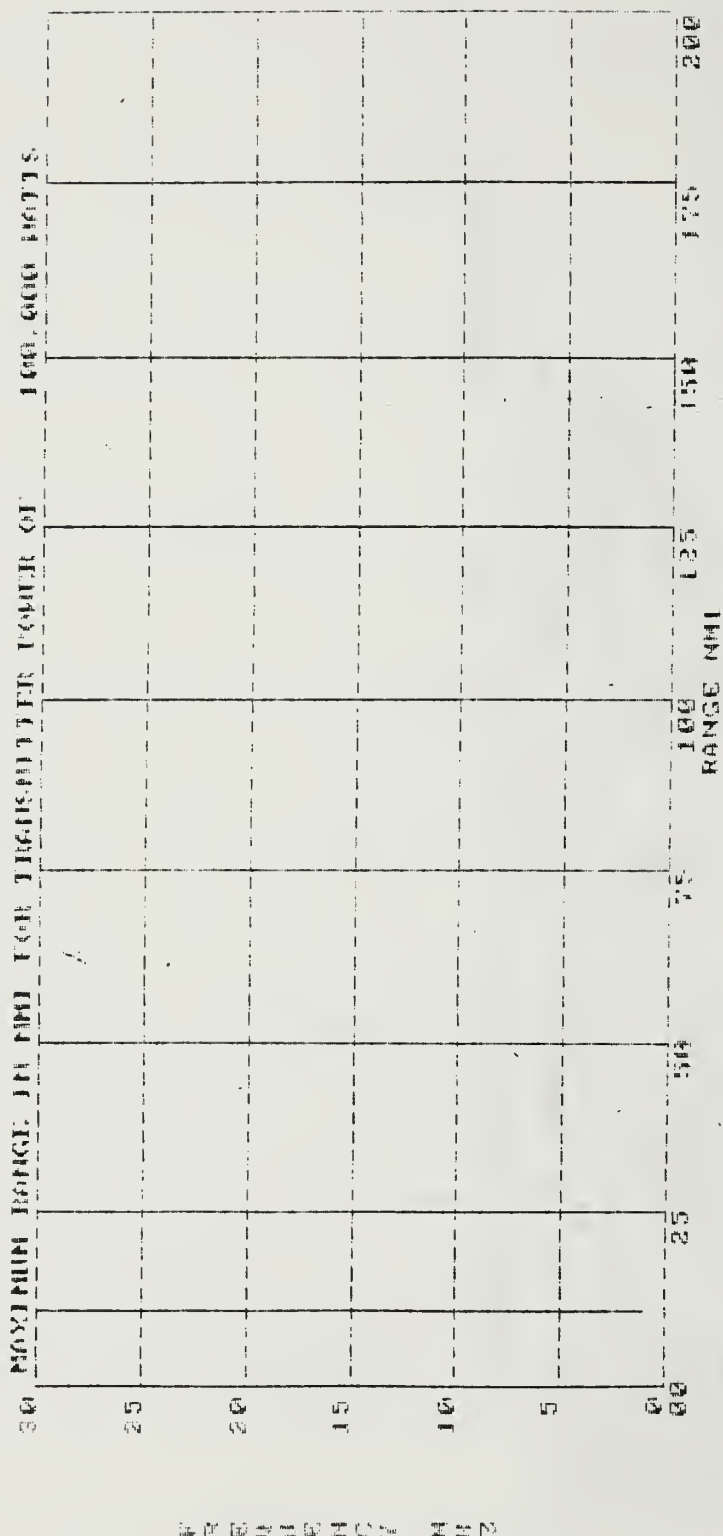


Figure 5 Ground Wave Range vs. Frequency,
 Horizontally Polarized Signal.

maximizing ground wave propagation. In general, lower frequencies yield greater ground wave coverage.

Increasing the critical ray angle is done by proper frequency selection. Since optimum frequency is tied to a dynamic ionosphere, propagation programs such as Advanced Prophet are essential tools.

The Advanced Prophet scenario illustrated that helo 4, at 50 nm, essentially always communicated via ground wave. Helos 1 and 2 would generally utilize sky wave propagation and the frequency "windows" for effective communication were seen to be from about 3 to 9 MHz depending on time of day and other solar conditions. Their ray angles as determined by the Prophet program ranged from 45 to 76 degrees with an average angle of about 64 degrees above the horizon.

Signals which are transmitted at large elevation angles are said to be propagating in the Near Vertical Incidence Skywave mode (NVIS). The average of 64 degrees may be taken as the optimum launch angle for 100 to 200 nm one hop NVIS propagation. With this average figure in mind an antenna system can be designed to produce maximum gain and a uniformly distributed radiation pattern at the optimum elevation angle. Polarization of the vertically radiated signal is not important since the effects of reflection from the ionosphere tend to produce random

polarization in sky wave signals [Refs. 6, 7]. Consequently, only the total radiation pattern is of concern for sky wave propagation.

III. MODELING

A. NUMERICAL ELECTROMAGNETICS CODE (NEC)

The Numerical Electromagnetics Code (NEC) is a FORTRAN computer program which is used to analyze the electromagnetic response of metal structures. Antennas, wires, masts, surfaces, or virtually any other metal structure may be modeled and analyzed using NEC. Structures may be modeled in free space or over a ground plane. While it is possible to push the code beyond its limits careful modeling and analysis with NEC provides accurate results from 2 MHZ through 25 GHZ [Ref. 8, 9]. NEC requires a main-frame computer, but a smaller micro-computer based version of the code called MININEC is also available.

The code performs a numerical solution of integral equations for currents induced on the structure using a form of Method of Moments for "point matching" at each wire segment center. Kirchoff's Current Law is enforced on segments at wire junctions to reduce the linear equations to a manageable number which are then solved by the Gauss-Doolittle method.

Once the current on each segment is known, the radiation patterns are obtained by numerical integration

of the RF current distribution on the model. Output is in tabular form, easily accessible for processing with graphical routines.

Excellent detailed descriptions of the NEC code are found in References 8, 10 and 11.

B. INTERACTIVE GRAPHICS UTILITY FOR AUTOMATED NEC ANALYSIS (IGUANA)

NEC requires input geometry cards for each wire in the model. Every card must include the coordinates in three-space of both end points as well as the wire radius and segmentation. Developing this type of model accurately is a lengthy, tedious, and error prone process. The data must be checked and re-checked to ensure measurement and keyboard errors are not present in the model. IGUANA is a user-friendly micro-computer based program which provides a partially automated system for both data entry and display. Its use greatly reduces the time and effort required for accurate model development.

Data entry begins by using a digitizer to enter lines from a two-view scale drawing. The program converts this data into a three-dimensional wire model and displays the entire structure graphically. The program has the capability of rotating the displayed structure and of magnifying selected portions (zooming). The user can

edit the displayed structure via mouse, adding or removing wires and points as desired. When the model is completed the program will generate the required geometry data cards in NEC format. Utilities which include optional prompts are available within IGUANA to create or edit the NEC comment, geometry, or program control cards. [Ref. 12]

C. DOLPHIN MODEL

The Coast Guard's SRR helicopter, the HH-65A Dolphin, was modeled as an equivalent grid of wires. The use of wire grid models for complex bodies has been well documented [Ref. 8, 13]. Some concern existed for this case, however, because of the high level of composite materials in the make-up of this aircraft. The vertical fin was almost all carbon fiber composite material, while the tail cone panels consisted of an inner and outer metal skin with a nomex honeycomb material sandwiched between them. The individual panels were electrically insulated from one another for corrosion prevention purposes (Figure 6). Except for the vertical tail, fins, and horizontal stabilizer, the wire model was constructed as though this was a standard metal helicopter in the belief that, at RF, the framework would have appeared solid. The vertical tail, fins, and horizontal

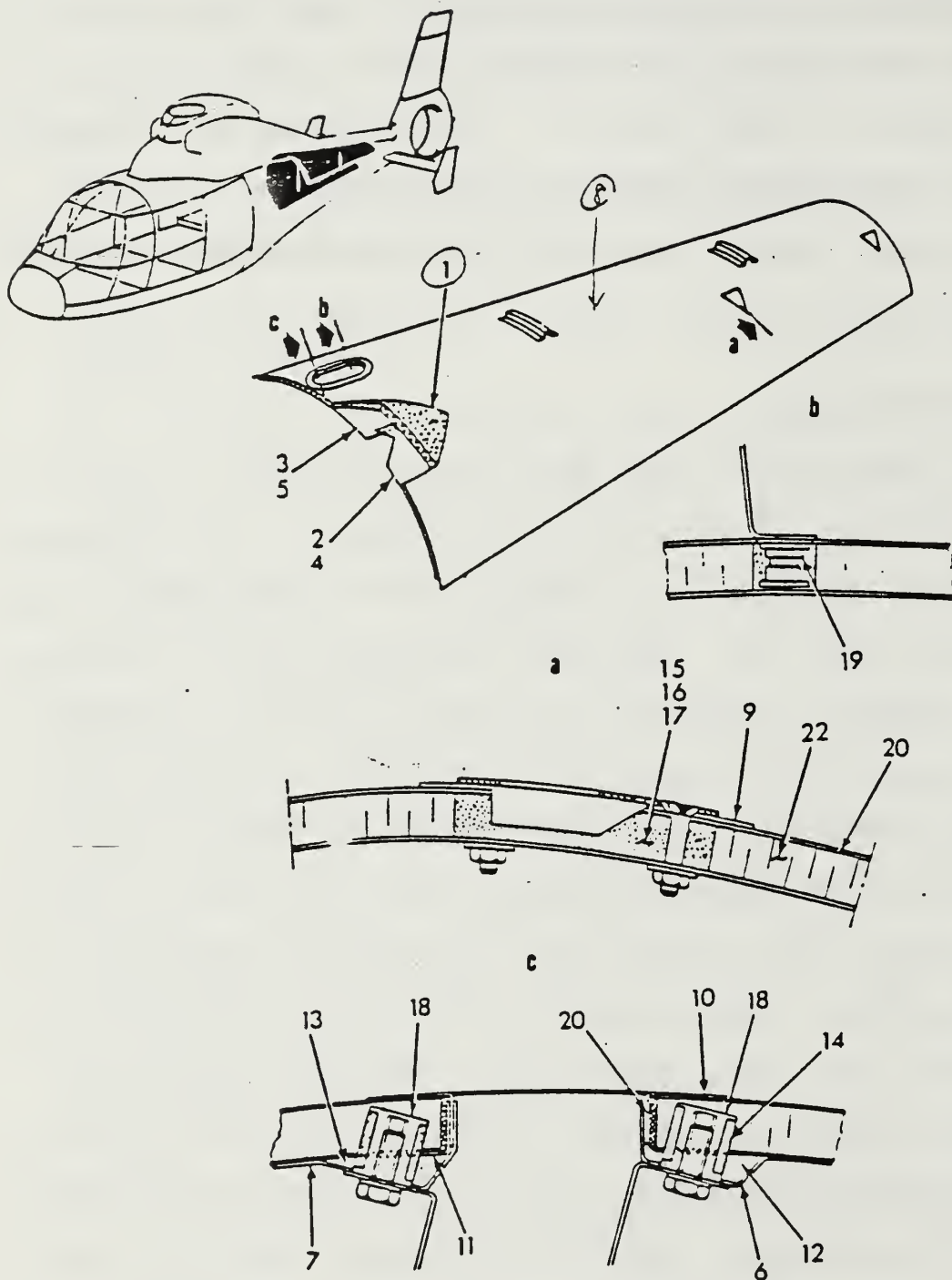


Figure 6 Dolphin Skin Panels.

stabilizer were modeled with a coarser wire grid because of their highly composite makeup.

A simple wire antenna model was developed to simulate each of four HF antenna systems contemplated for use on the Dolphin. These were:

1. The original long-wire antenna (Fig. 7,8)
2. The Collins 437R-2 tuned monopole antenna (Fig. 9,10)
3. The tube or transmission line antenna (Fig. 11,12)
4. The long shunted loop antenna (Fig. 13,14)

Restrictions on segment lengths and wire radii in terms of wave length (frequency) were delineated in Reference 11. The frequencies investigated varied from 3 to 18 MHz, so a convenient wire radius seemed to be one inch (.0254m), while nominal segment length was .5 meters. Prior experience indicated that segments near the excitation point needed to be kept as small as possible for an accurate model of the feed region [Ref. 8], and so, consistent with the restrictions of Reference 11, the segment lengths on the antenna models were minimized.

D. SEA HAWK MODEL

The initial geometry data cards for the HH-60J Sea Hawk, the Coast Guard's MRR helicopter, were obtained from ESL, a division of TRW. Since this Sea Hawk model was developed without the benefit of the IGUANA program

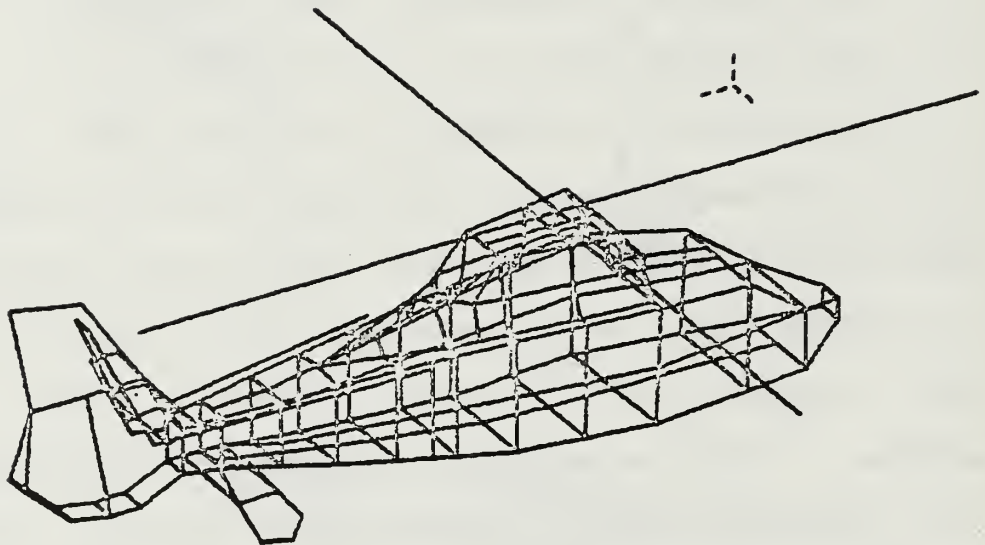


Figure 7 Dolphin Model with Long-wire.

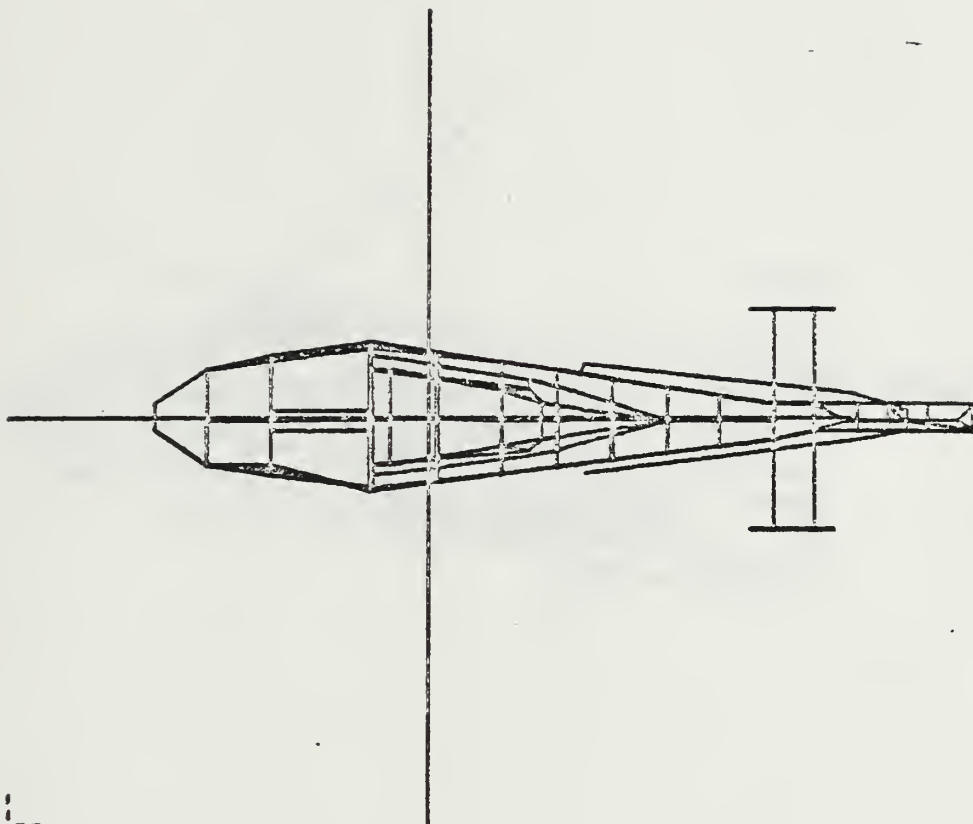


Figure 8 Dolphin Model with Long-wire, Top View.

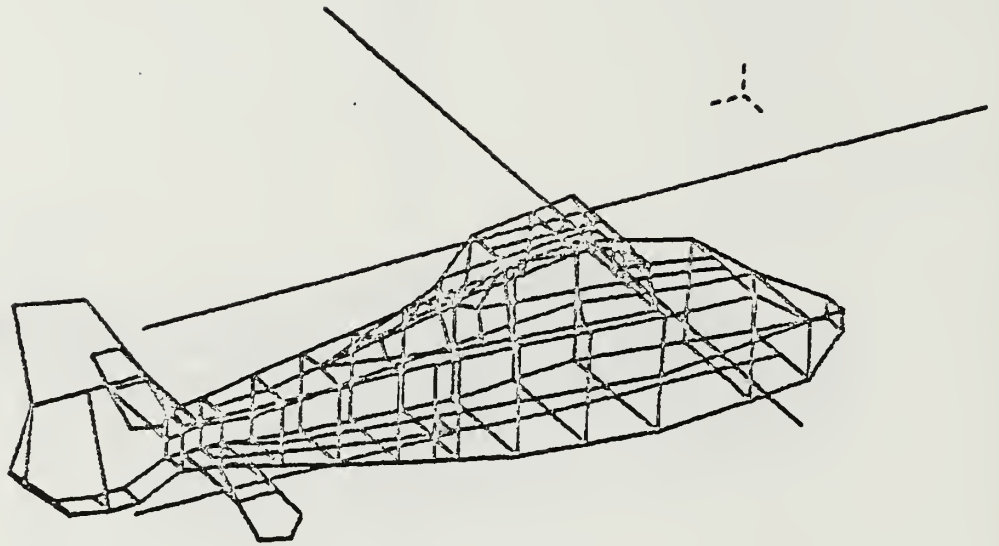


Figure 9 Dolphin Model with Tuned Monopole.

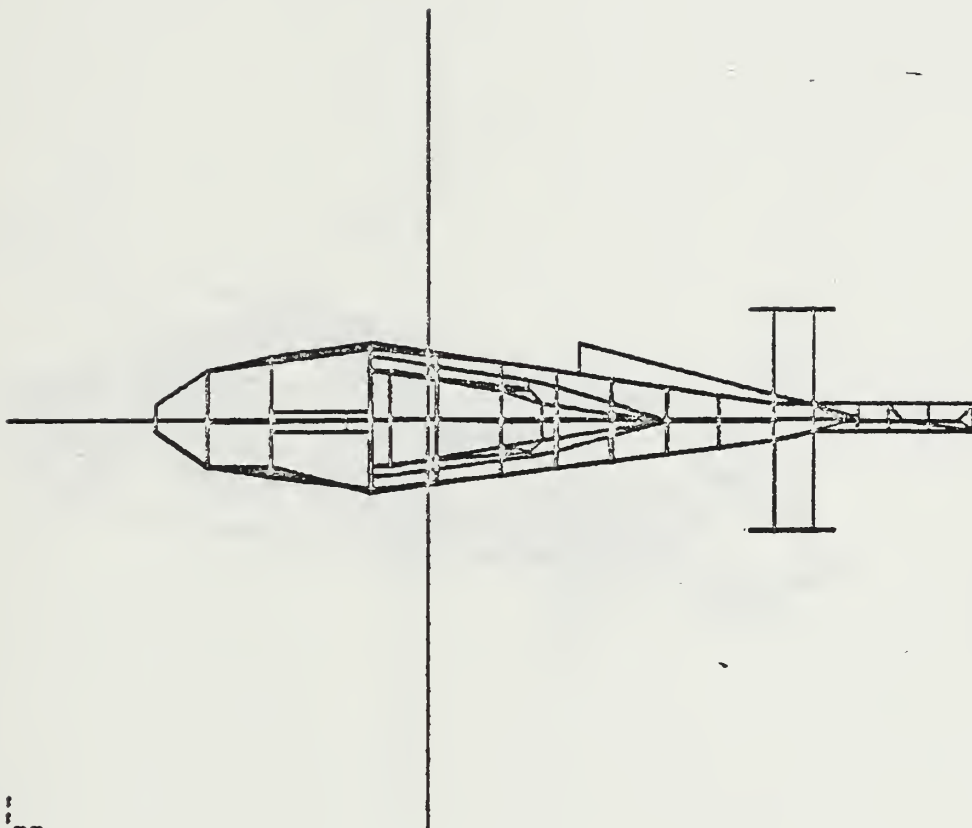


Figure 10 Dolphin Model with Tuned Monopole,
Top View.

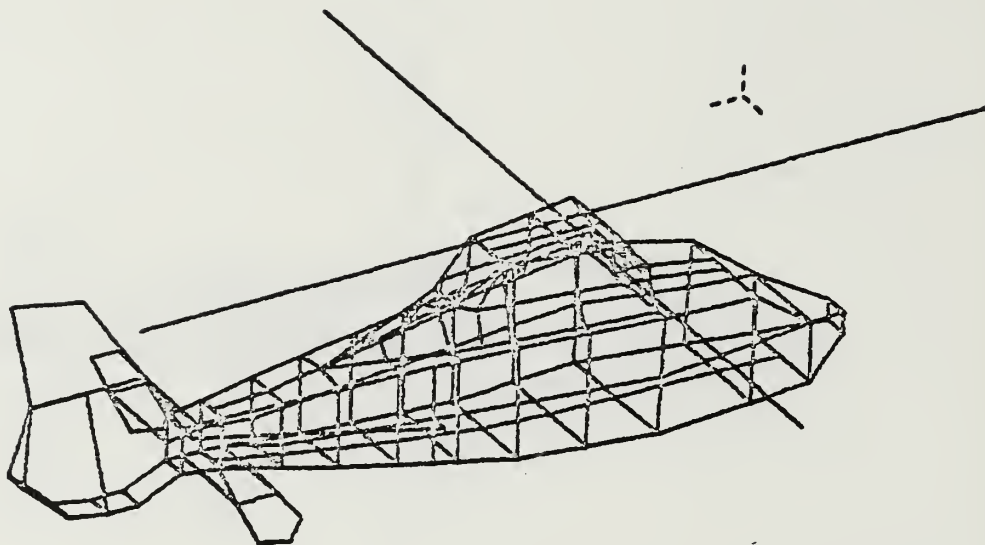


Figure 11 Dolphin Model with Transmission Line.

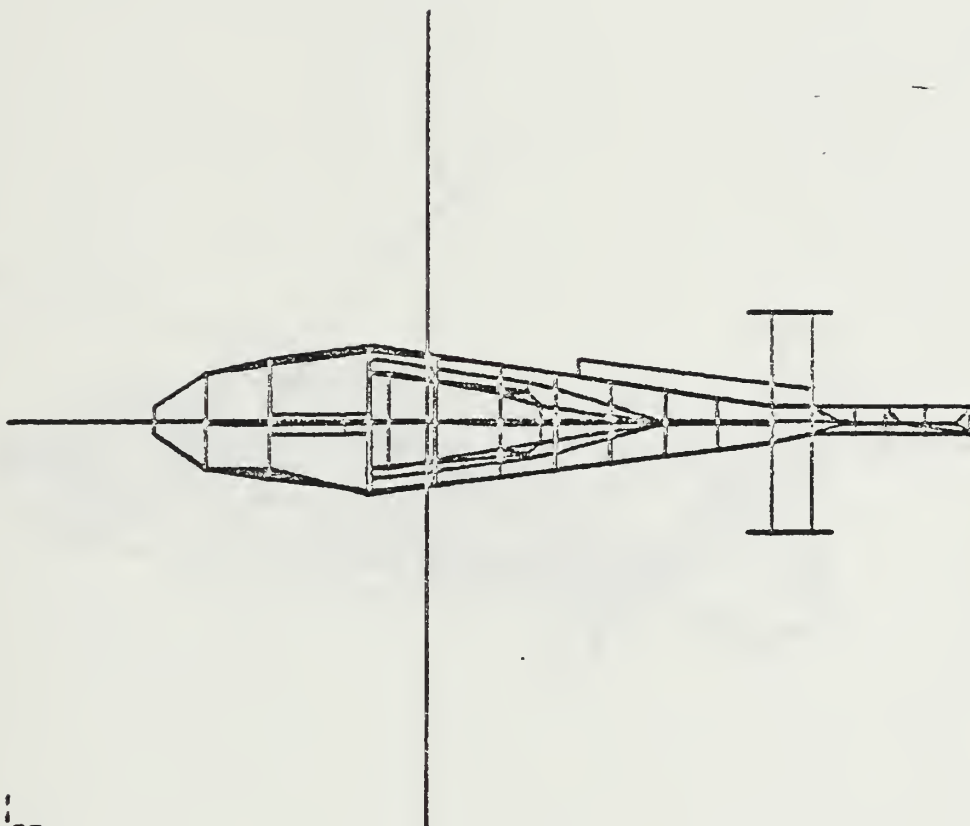


Figure 12 Dolphin Model with Transmission Line,
Top View.

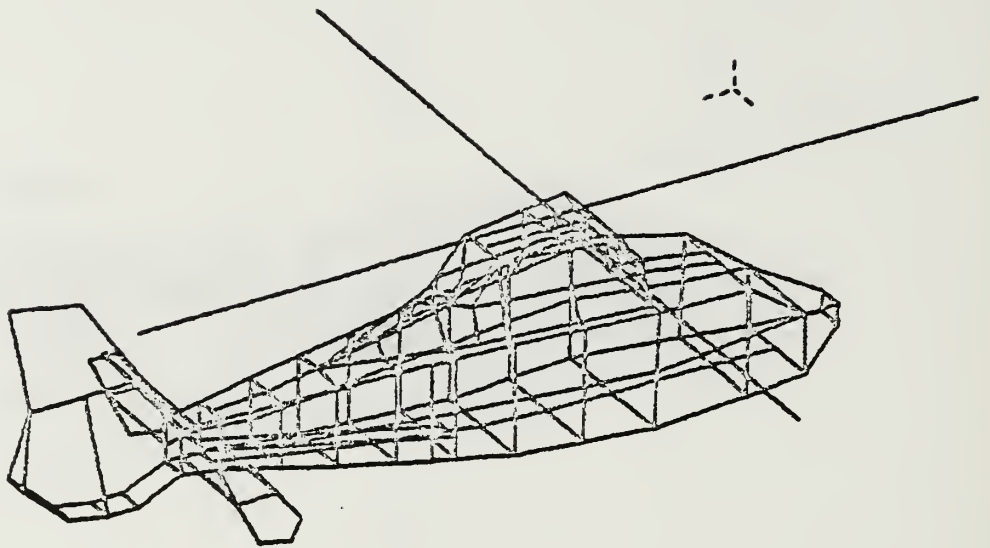


Figure 13 Dolphin Model with Long Shunted Loop.

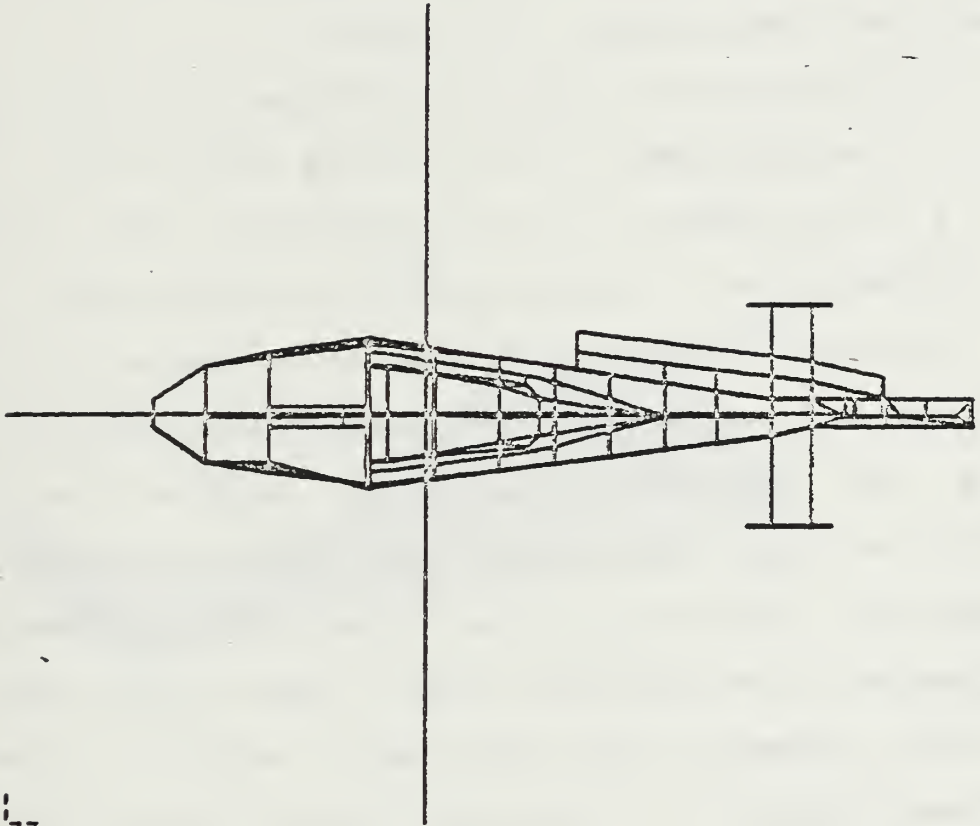


Figure 14 Dolphin Model with Long Shunted Loop,
Top View.

it tended to be a bit less complex than the Dolphin model. The data cards were input into IGUANA and the geometry was modified to include a horizontal stabilizer and a more dense vertical tail.

Similarly, wire models were developed for each of the Sea Hawk's HF antennas. They were:

1. The original long-wire configuration (Fig. 15,16)
2. Navy placement of the Collins 437R-2 (Fig. 17,18)
3. CG placement of the Collins 437R-2 (Fig. 19,20)
4. The tube or transmission line antenna (Fig. 21,22)

When the Sea Hawk model was run at frequencies below 13 MHz with the original long-wire antenna model attached the code was unable to model the currents accurately. Negative input impedance and negative radiated power were observed. Initially, it was thought that shortening the segments on the helicopter body to more closely match the antenna segment length would help, but this correction proved ineffective. Large wire radius jumps at junctions have been known to cause the same problem [Refs. 8, 14], but all wires in this model were equal in radius. Finally it was noted by G. J. Burke that the NEC code has some limitations in modeling electrically small antennas in the vicinity of loops [Ref. 15]. In this case the loops were formed by the wire grid making up the helicopter body. The loop currents at low frequencies

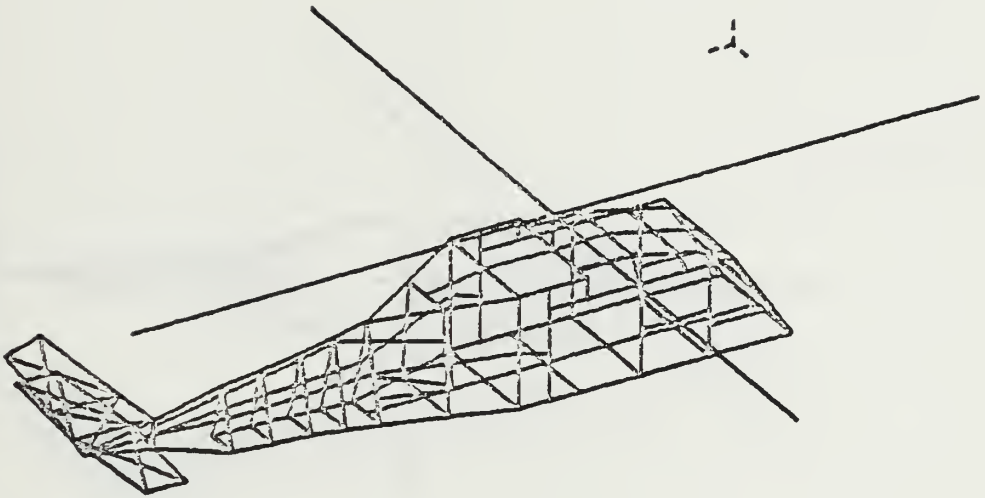


Figure 15 Sea Hawk Model with Long-wire.

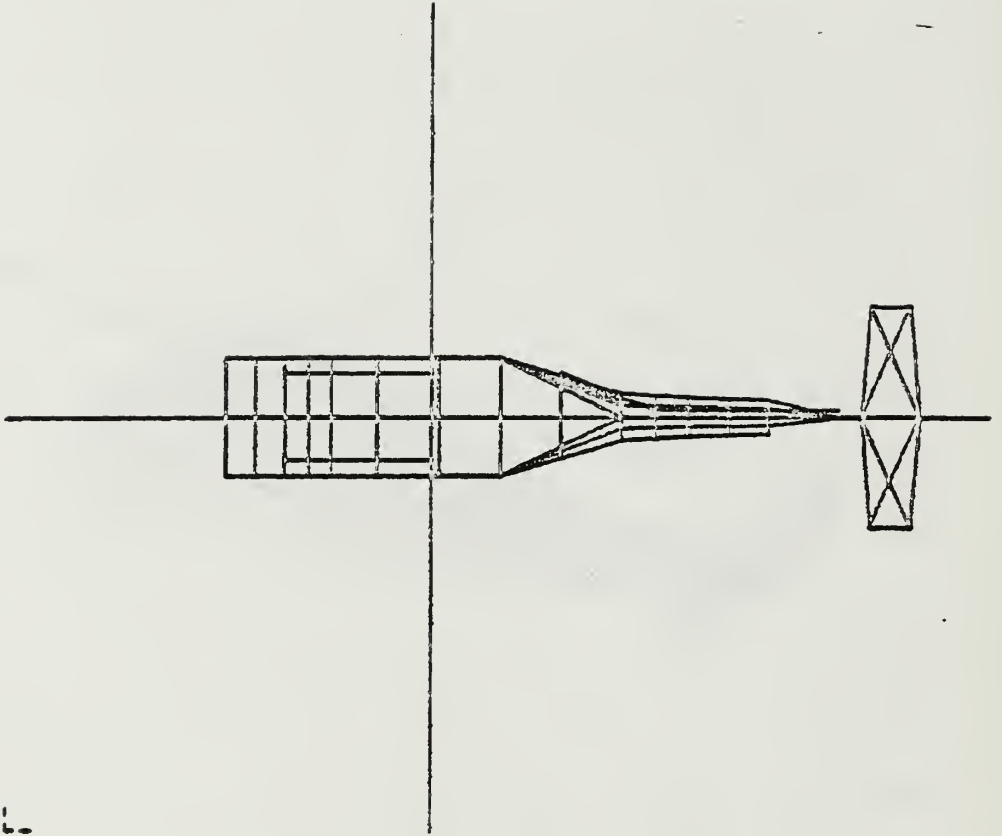


Figure 16 Sea Hawk Model with Long-wire, Top View.

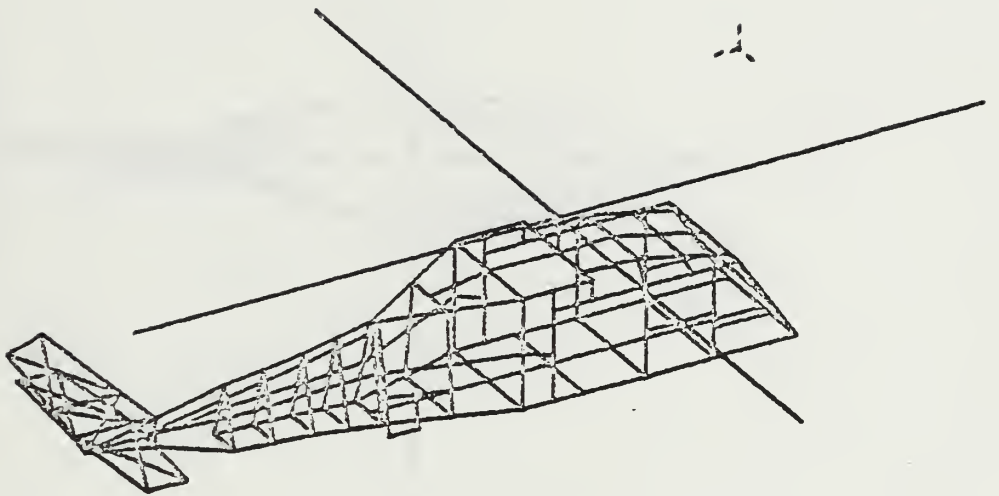


Figure 17 Sea Hawk Model with Navy Tuned Monopole.

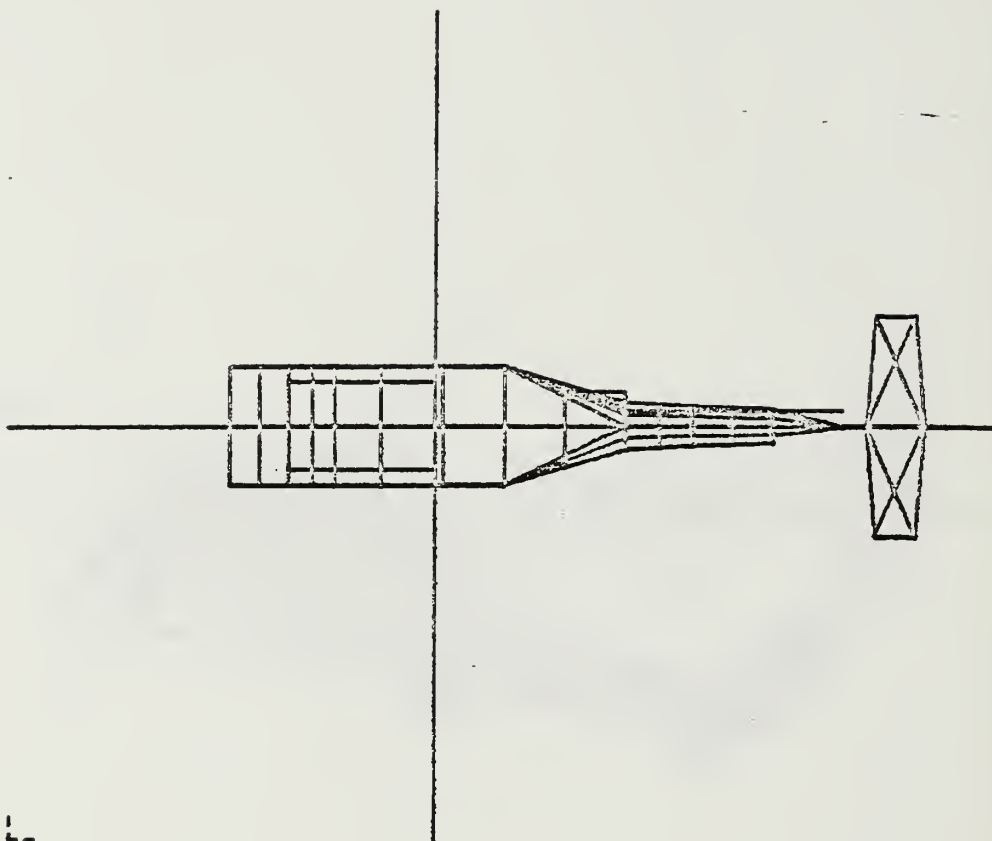


Figure 18 Sea Hawk Model with Navy Tuned Monopole,
Top View.

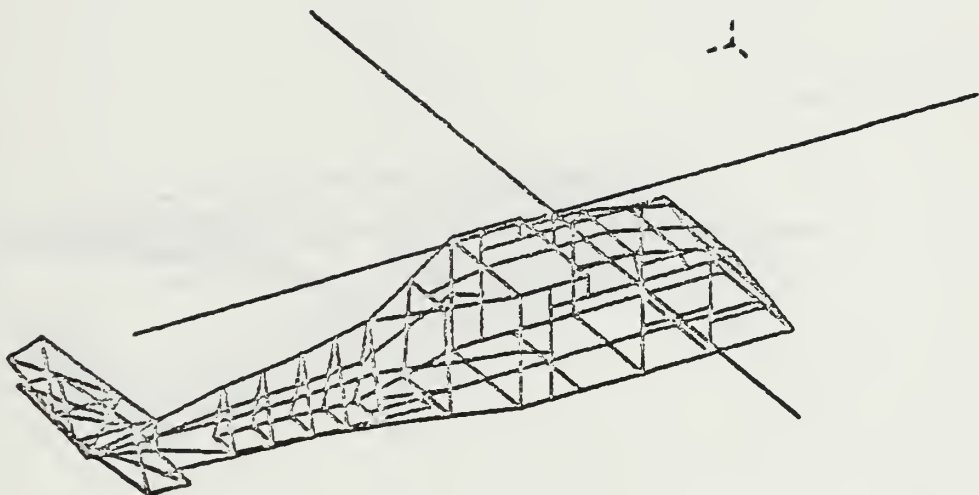


Figure 19 Sea Hawk Model with CG Tuned Monopole.

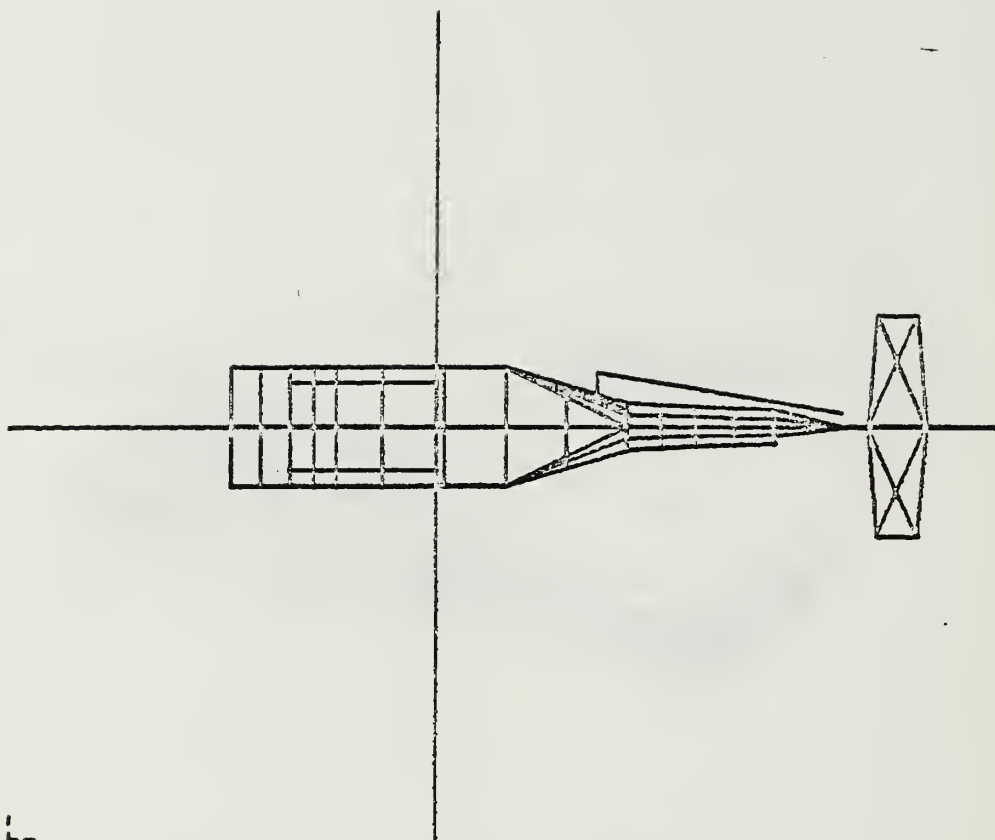


Figure 20 Sea Hawk Model with CG Tuned Monopole,
Top View.

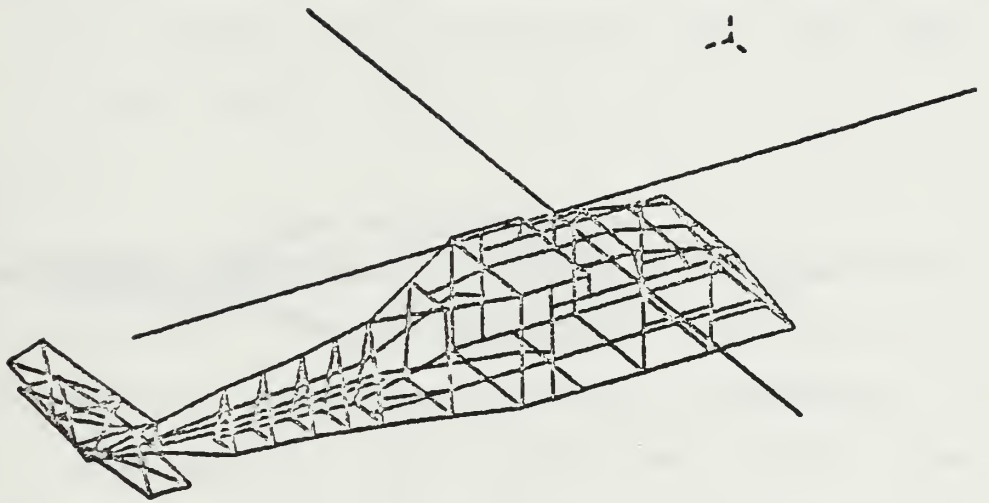


Figure 21 Sea Hawk Model with Transmission Line.

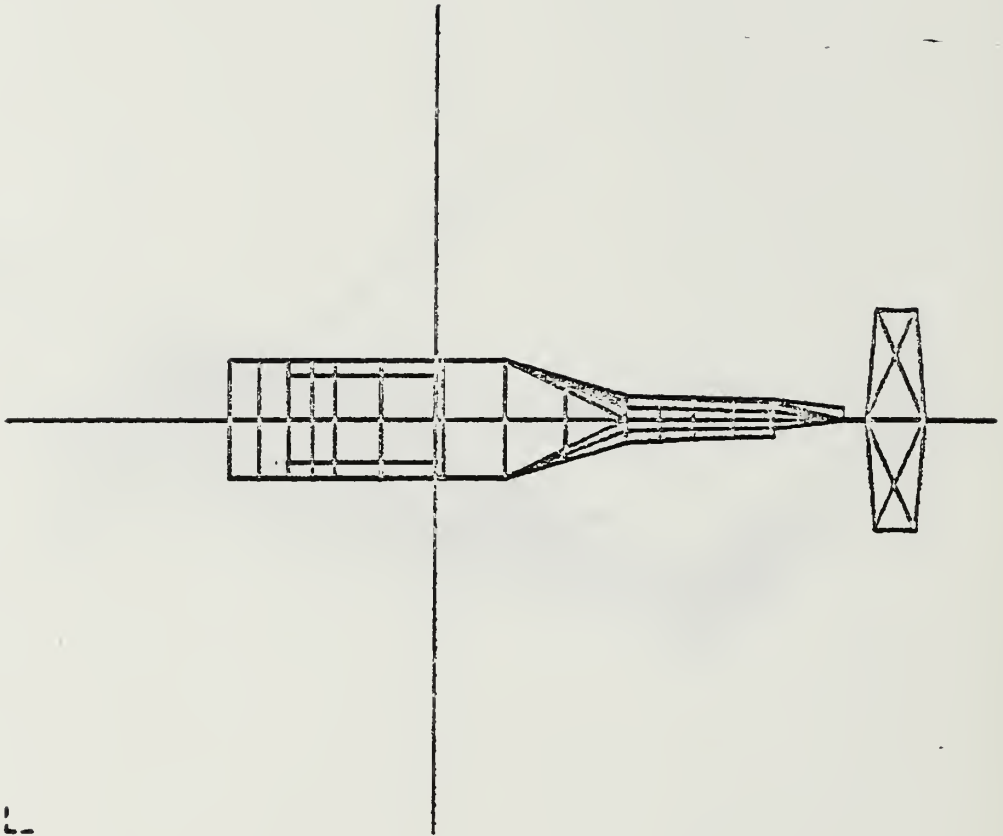


Figure 22 Sea Hawk Model with Transmission Line,
Top View.

became proportional to $1/f$ while the antenna current was proportional to f which was clearly wrong. The interaction matrix for the loops became ill-conditioned at the lower frequencies. Mr. Burke observed that this problem could be minimized by spacing the antenna further from the loops. Indeed, by moving the antenna out from 6 inches to 18 inches from the aircraft skin the code provided accurate results. [Ref. 15]

E. NEC RUNS

The NEC code computes the currents resulting from an applied excitation. The RF current distribution must meet the boundary condition that axial components of electric fields must go to zero along each wire. The excitation used in this study takes the form of an applied voltage at the antenna feed point which becomes a non-zero source field at the short segment of wire across the feed point with a zero excitation elsewhere on the structure. The currents are computed by NEC as described earlier, and finally radiation patterns are tabulated.

Individual NEC runs were made for each helicopter model at Coast Guard air-to-ground frequencies of 3.123, 5.696, and 8.984 MHz as well as at Naval Air Test Center frequencies of 4.040, 7.645, 13.974, and 18.100 MHz. For

each run the matrix for the helicopter itself was calculated as a Numerical Green's Function (NGF) partitioned matrix solution and recalled for use with the various antenna models. This procedure allowed multiple radiation patterns to be collected for each antenna configuration at a specified frequency with one run in a fraction of the CPU time otherwise required. Even so, each run required 30 to 45 minutes of CPU time (IBM 370/3033). It was discovered that the NGF was too large to be stored on the users own disk, and that spooling the file to and from the reader (main frame storage) cost more money than the calculation of the NGF itself. Consequently, the NGF was re-calculated for each run.

Each model was validated using the code's average gain calculation. This was a performance criteria based on volumetric pattern integration and has been known to be an excellent self-validation tool [Ref. 13]. Correlation of the NEC horizontal plane radiation patterns with actual antenna test range data was also performed.

IV. RESULTS

A. GENERAL

NEC free space radiation patterns were obtained for each helicopter/antenna configuration at frequencies of 3.123, 4.040, 5.696, 7.645, 8.984, 13.974, and 18.1 MHz. Four cuts were taken for each configuration at each frequency:

1. Horizontal plane, $\theta = 90$ degrees
2. Elevation 64 degrees above horizontal, $\theta = 26$ degrees
3. Vertical plane, nose to tail, $\phi = 0$ degrees
4. Vertical plane, offset, $\phi = 45$ degrees

Vertically and horizontally polarized gains as well as total gain were plotted relative to isotropic signal levels in decibels (dBI). Patterns at frequencies above 10 MHz were included solely to compare the NEC output with test range data since NVIS propagation required use of the lower end of the HF spectrum (2 to 10 MHz). Vertical plane plots were included only as a matter of interest. Sample radiation pattern plots have been shown in Figures 23 through 26.

Comparison of horizontal plane radiation patterns with antenna test range data revealed satisfactory correlation for the horizontally polarized gains. The

H65 IGUANA DATA RUN AT 5.696MHZ ON 8/20/87

COLLINS 437R-2, FREE SPACE, HORIZ CUT, THETA=90

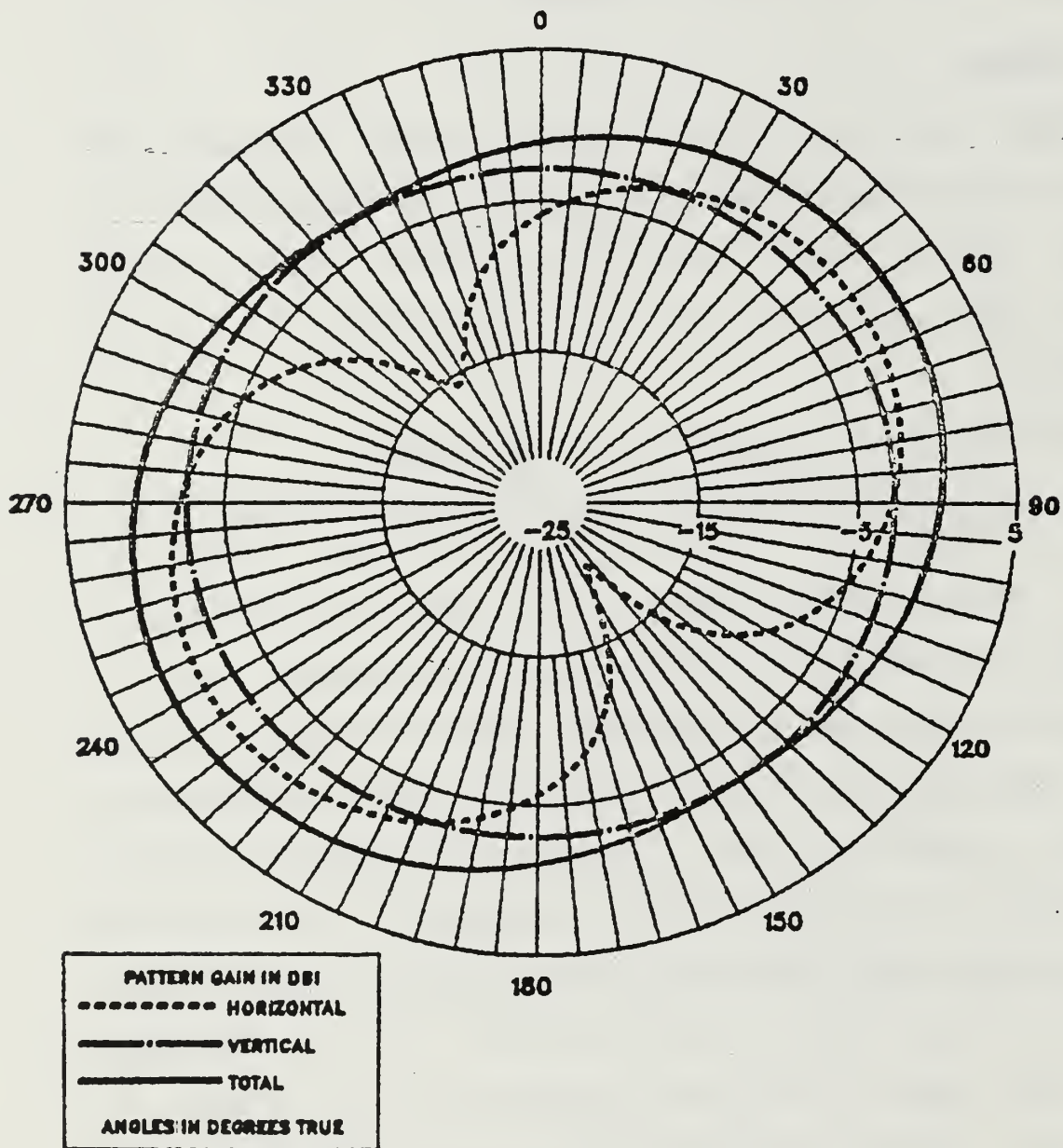


Figure 23 Radiation Pattern, Horizontal Plane,
Theta = 90.

H65 IGUANA DATA RUN AT 5.696MHZ ON 8/20/87

COLLINS 437R-2, FREE SPACE, HORIZ CUT, THETA=26

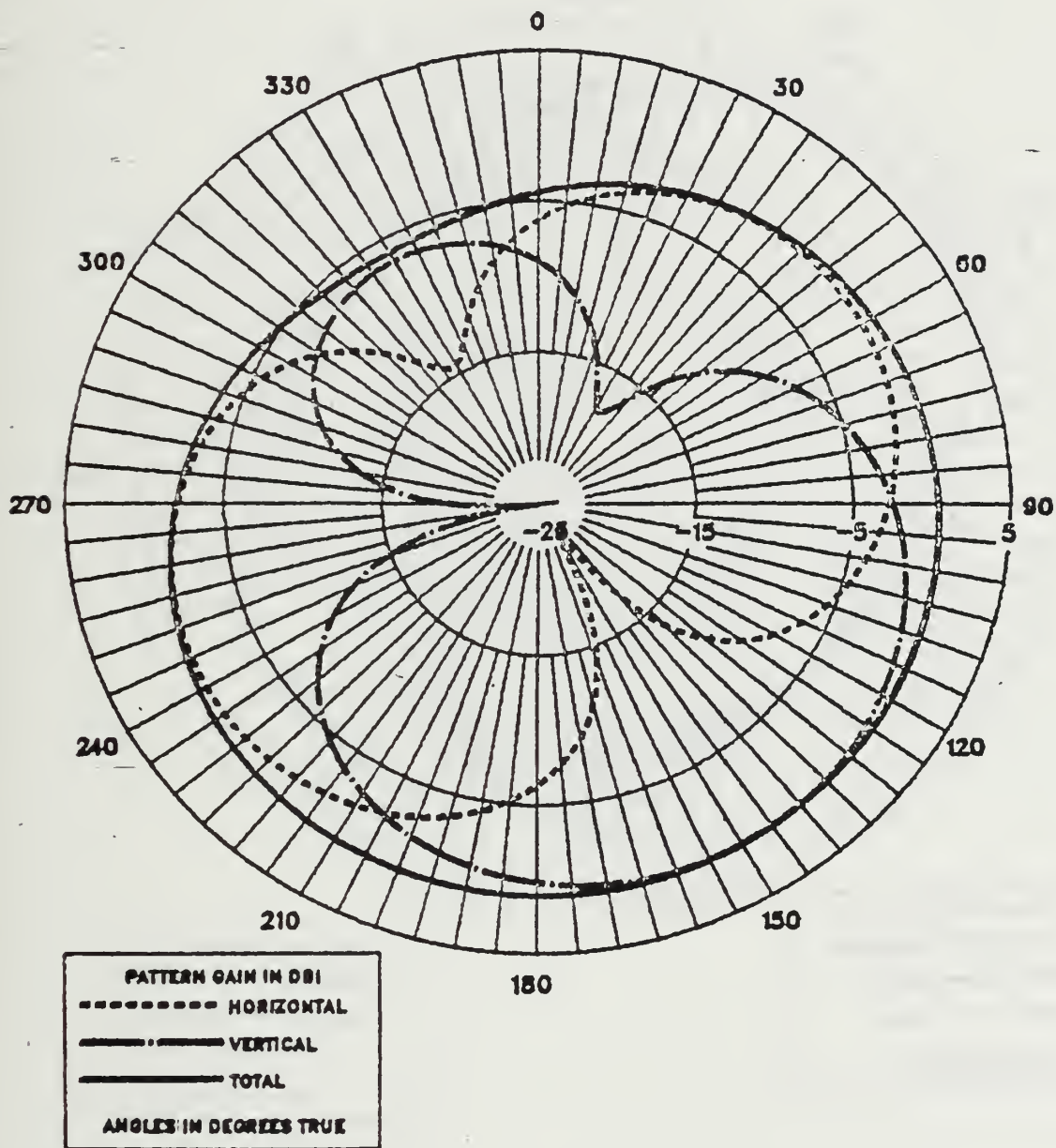


Figure 24 Radiation Pattern, Elevated Plane,
Theta = 26.

H65 IGUANA DATA RUN AT 5.696MHZ ON 8/20/87

COLLINS 437R-2, FREE SPACE, VERT CUT, PHI=0

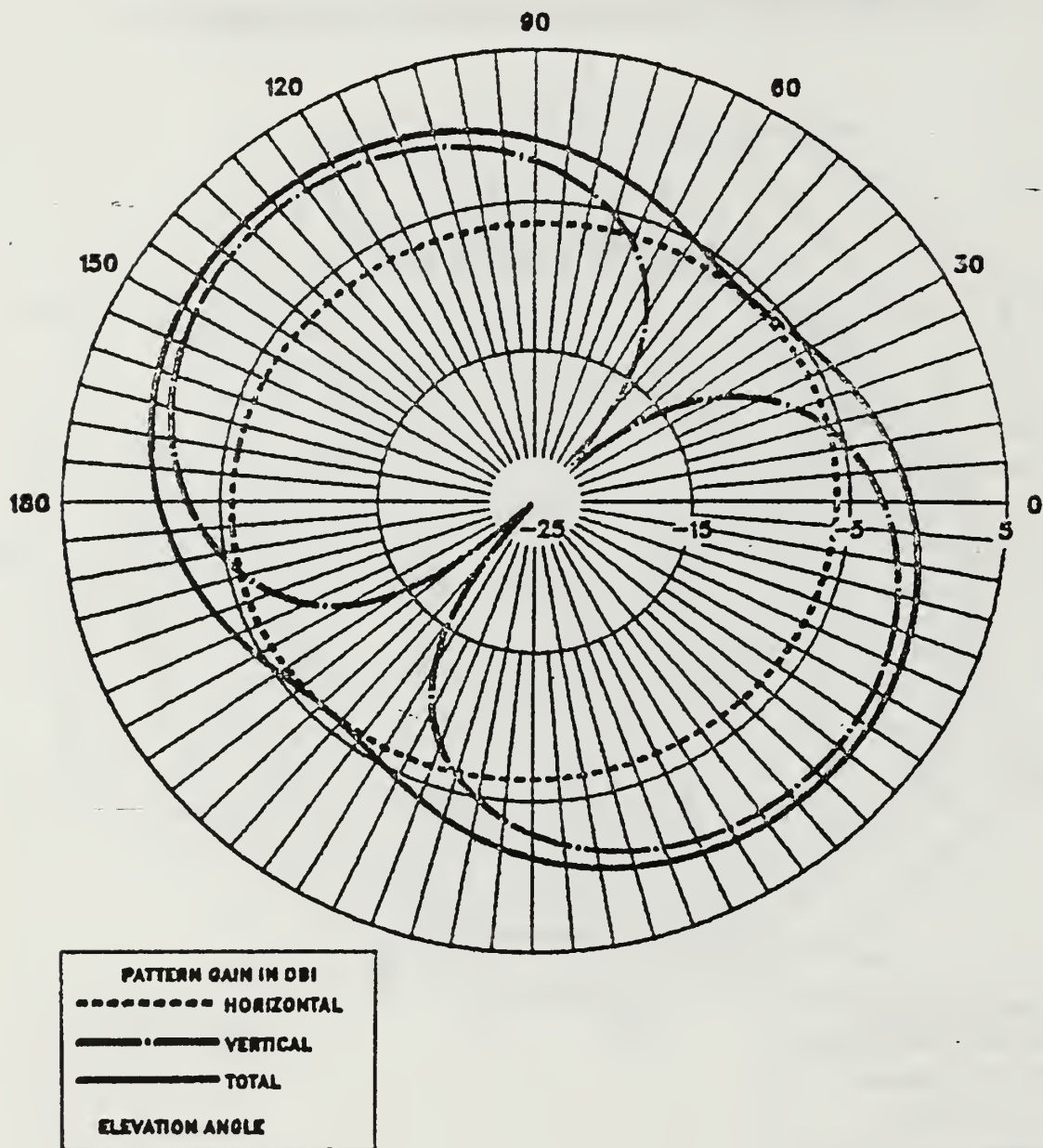


Figure 25 Radiation Pattern, Vertical Plane,
Phi = 0.

H65 IGUANA DATA RUN AT 5.696MHZ ON 8/20/87

COLLINS 437R-2, FREE SPACE, VERT CUT, PHI=45

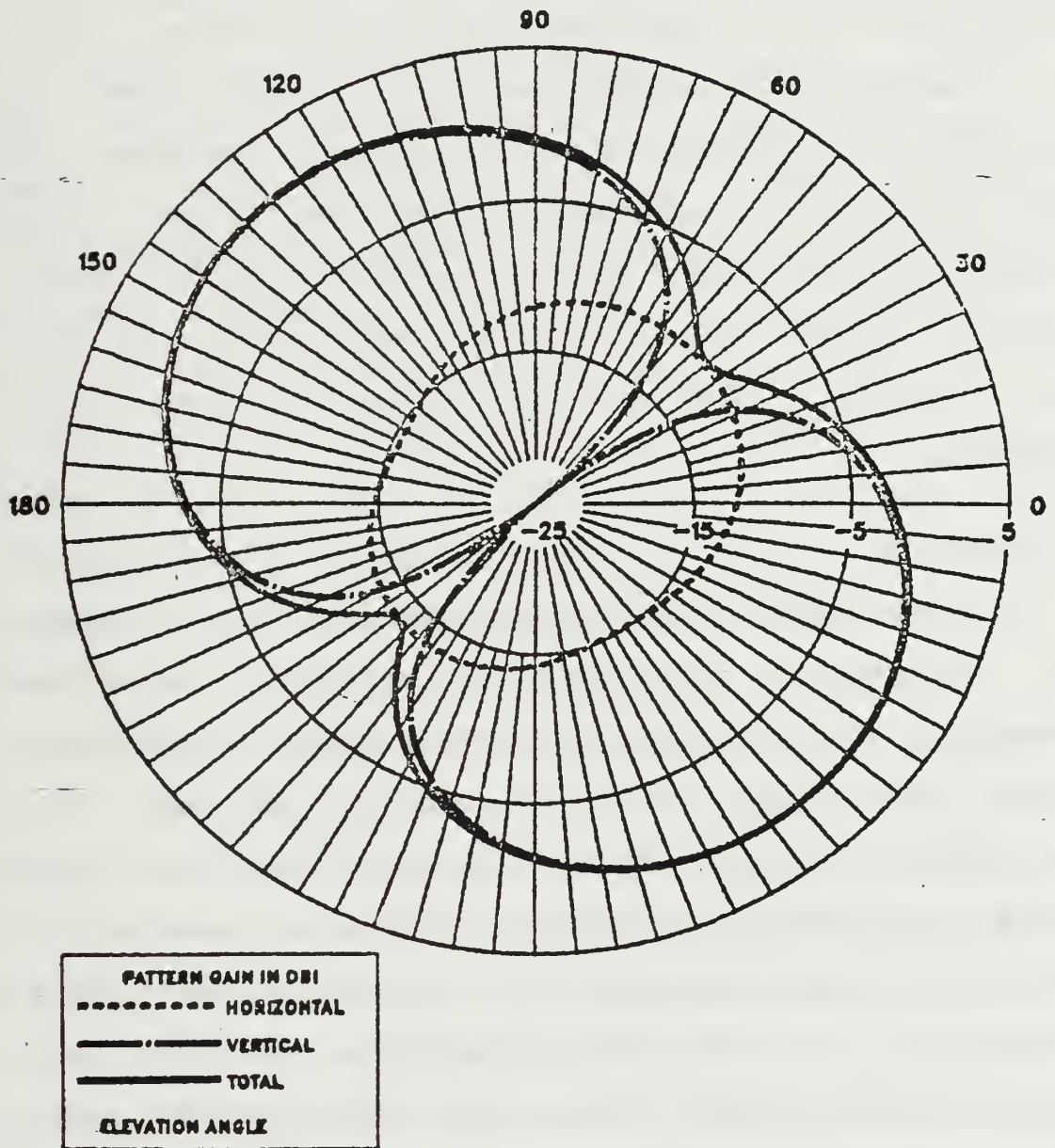


Figure 26 Radiation Pattern, Offset Vertical Plane,
Phi = 45.

NEC generated vertically polarized gain patterns were much stronger than the test range data. This was believed to be because the test range data was not corrected for the surface wave contribution [Refs. 1, 2, 16]. The shape of the NEC generated vertically polarized gain patterns corresponded well with test range data, as did the relative improvement or decrement in gain from long-wire to Navy tuned monopole antenna patterns. These positive correlations validated the model results insofar as relative comparisons of antenna systems were concerned.

B. DOLPHIN

As discussed earlier, enhanced ground wave coverage is achieved by maximizing the vertically polarized signals in the horizontal (azimuthal) plane. Horizontal plane cuts showed both loop antennas produced low vertically polarized gains (-10 to -15 dBI) and were quite directional. The long-wire antenna produced better vertically polarized gain (-5 to -10 dBI) but was still directional. The tuned monopole produced good vertically polarized gain (about -2 to -3 dBI) and was truly omnidirectional at all frequencies.

Performance in the NVIS mode was judged by total gain in the elevated cut. All four antennas performed well (virtually isotropic) with omnidirectional

characteristics for each except that the tuned monopole exhibited slight directionality.

C. SEA HAWK

A problem was discovered with the long-wire antenna model on the Sea Hawk at 5.696 MHZ. An apparent model resonance was encountered causing gains to be significantly inflated while pattern shapes appeared to be correct. Model resonance has been encountered in the past [Ref. 8], but with different manifestations. This problem was not encountered at the adjacent test frequencies of 4.040 and 7.645 MHZ, nor was it encountered with any other antenna configuration at any frequency. The long-wire configuration at 5.696 MHZ was, therefore, not reflected in the following discussion.

As in the Dolphin results, the vertically polarized gain in the horizontal plane cut of the loop antenna was always low and was directional at all but one frequency. The long-wire and Navy tuned monopole installations had vertically polarized gains that typically peaked between -5 and 0 dBI but were highly directional. The tuned monopole installed as on the Dolphin produced a gain of -5 dBI but was truly omni-directional at all frequencies.

In the NVIS mode the total gains were found to be virtually at isotropic levels and omni-directional for all antenna configurations except that the Navy tuned

monopole installation appeared to produce about +6 dBI
total gain.

V. CONCLUSIONS AND RECOMMENDATIONS

A. DOLPHIN

This study proves that the Collins 437R-2 HF Tuned Monopole antenna is the correct replacement for the Dolphin's troubled long-wire installation. Placement seems to be adequate, but further study and modeling could be performed to determine whether this location is truly optimum.

B. SEA HAWK

Based on the candidate antennas addressed in this study, an installation of the Collins 437R-2 tuned monopole antenna on the Sea Hawk in a configuration similar to that on the Dolphin is the best course of action to enhance HF performance on that aircraft. Further study to determine optimum antenna location would be useful. Especially important is "model tuning" as described in Ref. 7 to determine long-wire performance at the Coast Guard's primary air-to-ground frequency of 5.696 MHZ.

C. ADDITIONAL STUDIES

The modeling done in this study assumes that the transmitter and coupler aboard the helicopter can be

matched effectively with the candidate antennas at the frequencies tested. Follow-on studies could investigate the input impedance of these antenna installations and assess the degree of compatibility with existing matching networks.

Another interesting aspect to be studied is the possible "Rusty Bolt Effect." The possibility exists that the method used to "electrically isolate" pieces of the airframe, or the composite core itself, being in the vicinity of the HF antenna, may cause undesired semiconducting effects at junctions and interfaces. The resulting intermodulation products can seriously degrade the performance of a variety of avionics. [Ref. 17]

Although currently being studied by another university, a study and analysis of the antenna test range measurement methods at the Naval Air Test Facility, NAS Patuxent River, Maryland, could provide good thesis material for a student interested in applying antenna theory to a "real life" situation.

E. SUMMARY

Accurate electromagnetic models were created via the IGUANA program for the Dolphin and Sea Hawk helicopters as well as for long-wire, tuned monopole, and shunted-loop transmission-line-type antennas. The criteria for judging HF system effectiveness was devised from results

of the Advanced Prophet program. The models were used as input for the NEC program and the resulting radiation patterns were analyzed to select the optimum antenna configuration which met mission needs for each aircraft.

If the procedures and techniques for HF system modeling presented herein are utilized much time and money can be saved when designing or reconfiguring HF systems for optimum performance.

LIST OF REFERENCES

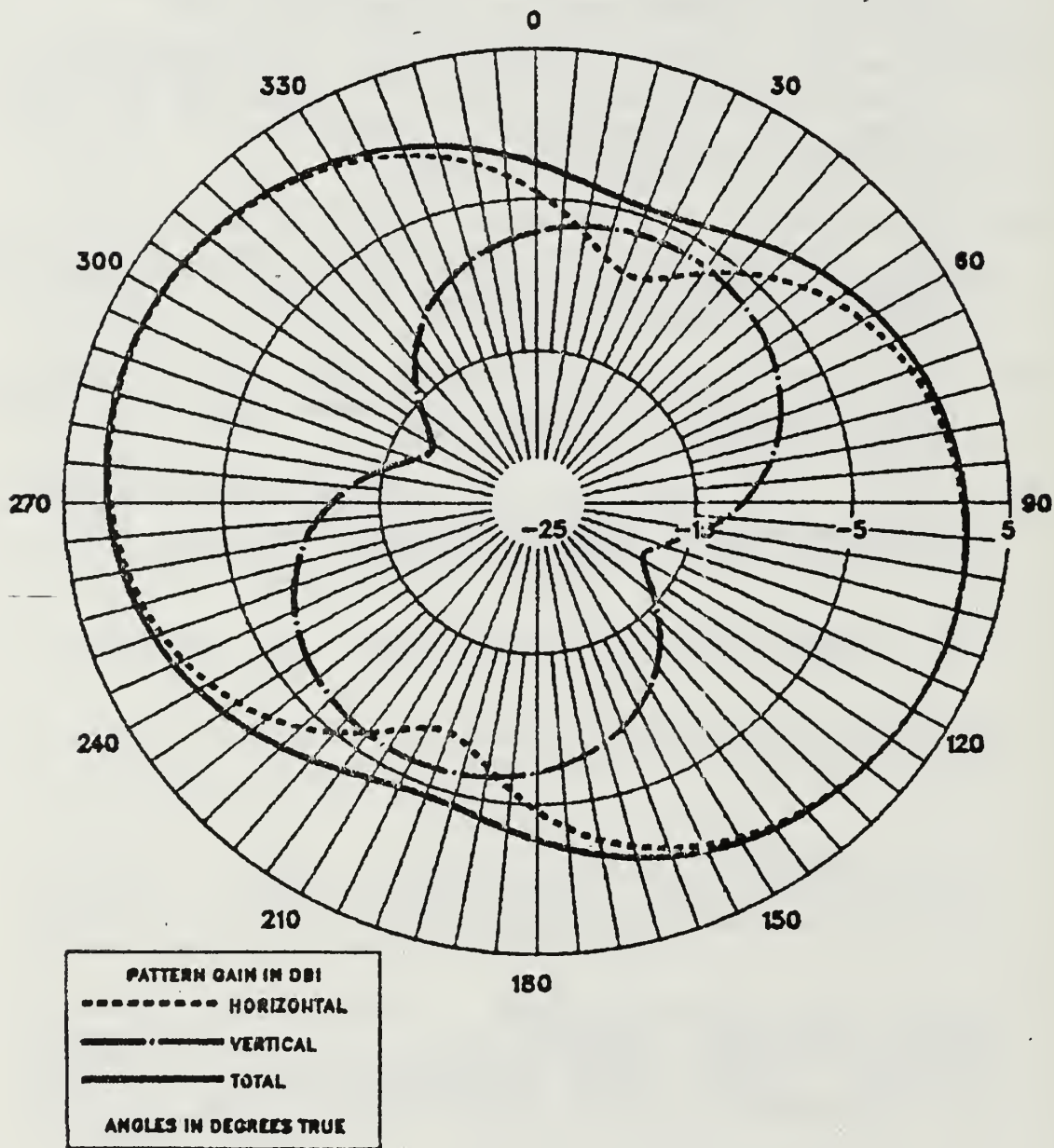
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17. Landt, J.A. "Effects of Nonlinear Loads on Antennas and Scatterers," AGAARD Lecture Series 131, 1983.

APPENDIX A
NEC RADIATION PATTERN PLOTS

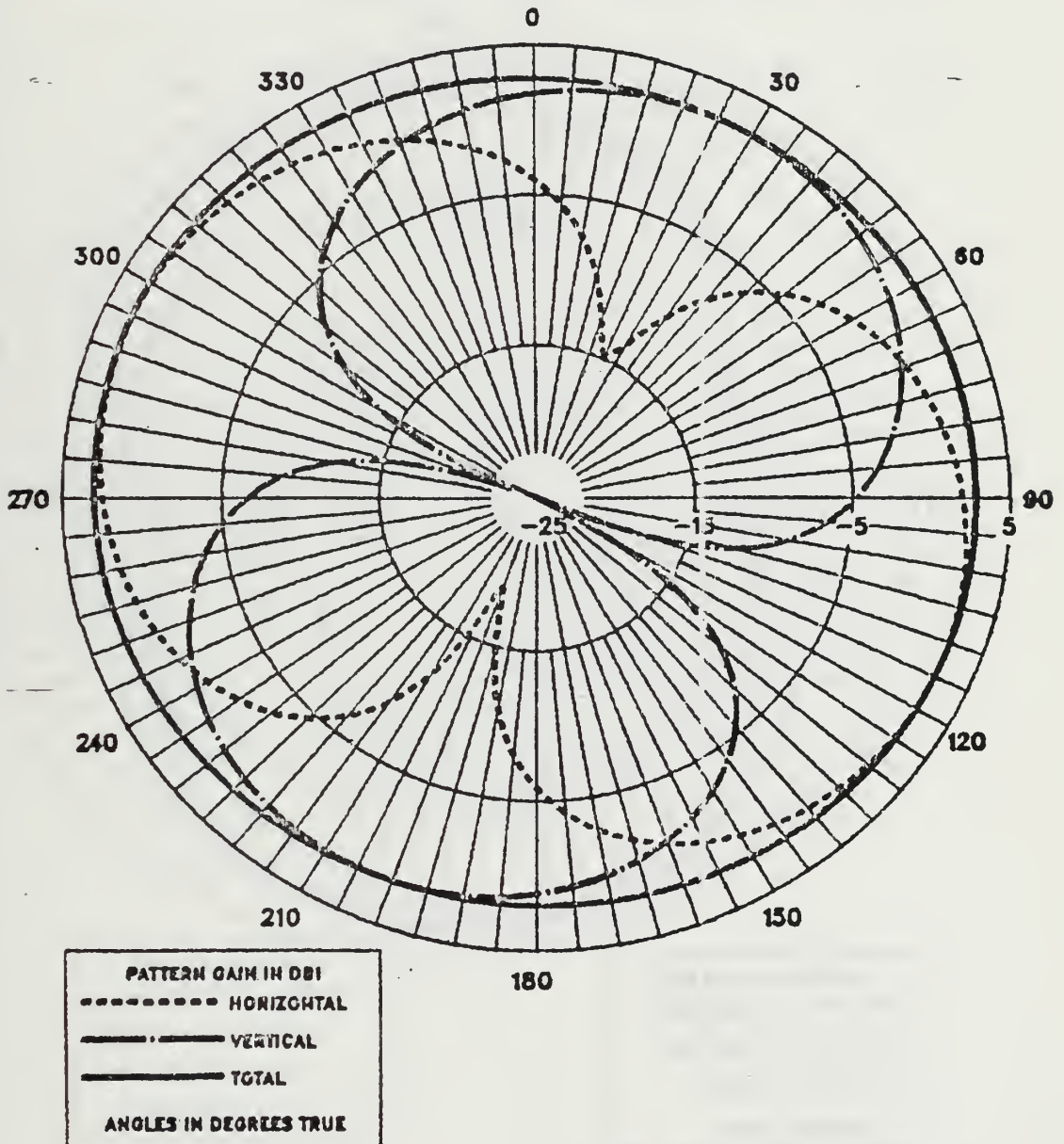
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LONG-WIRE ANT, FREE SPACE, HORIZ CUT, THETA=90



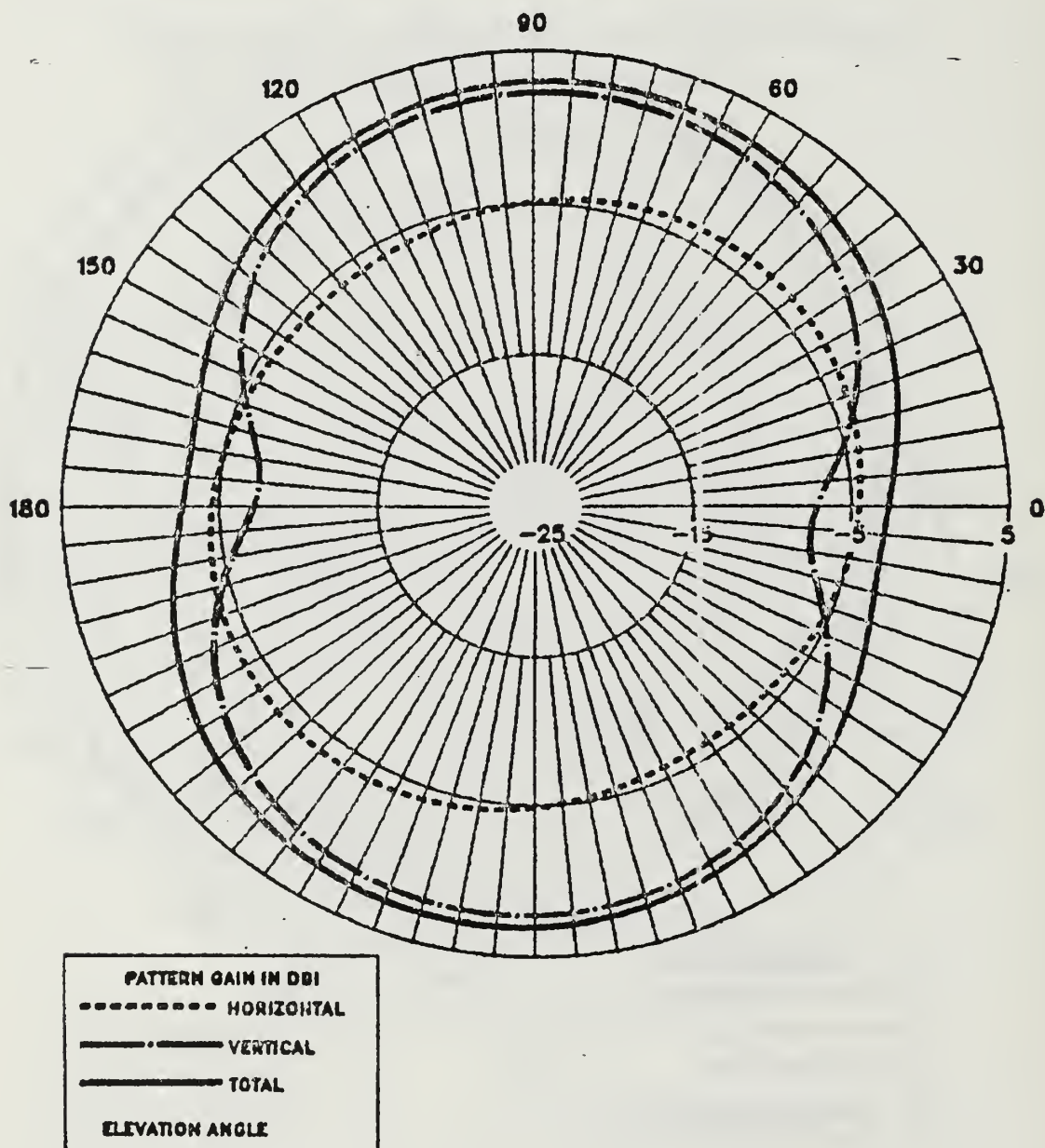
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LONG-WIRE ANT, FREE SPACE, HORIZ CUT, THETA=26



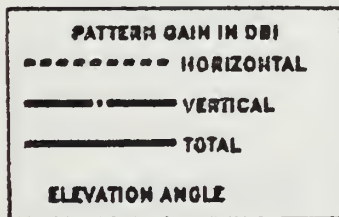
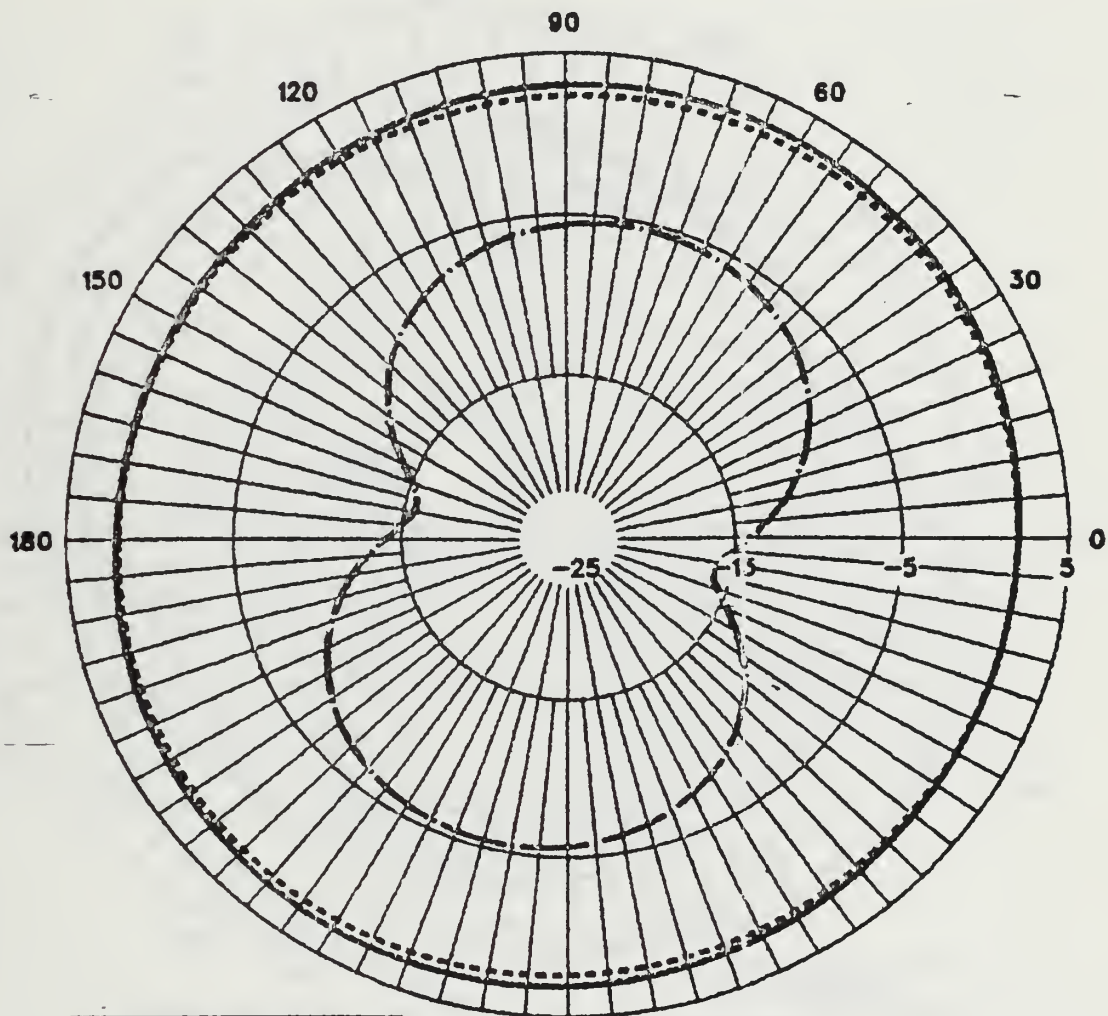
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LONG-WIRE ANT, FREE SPACE, VERT CUT, PHI=0



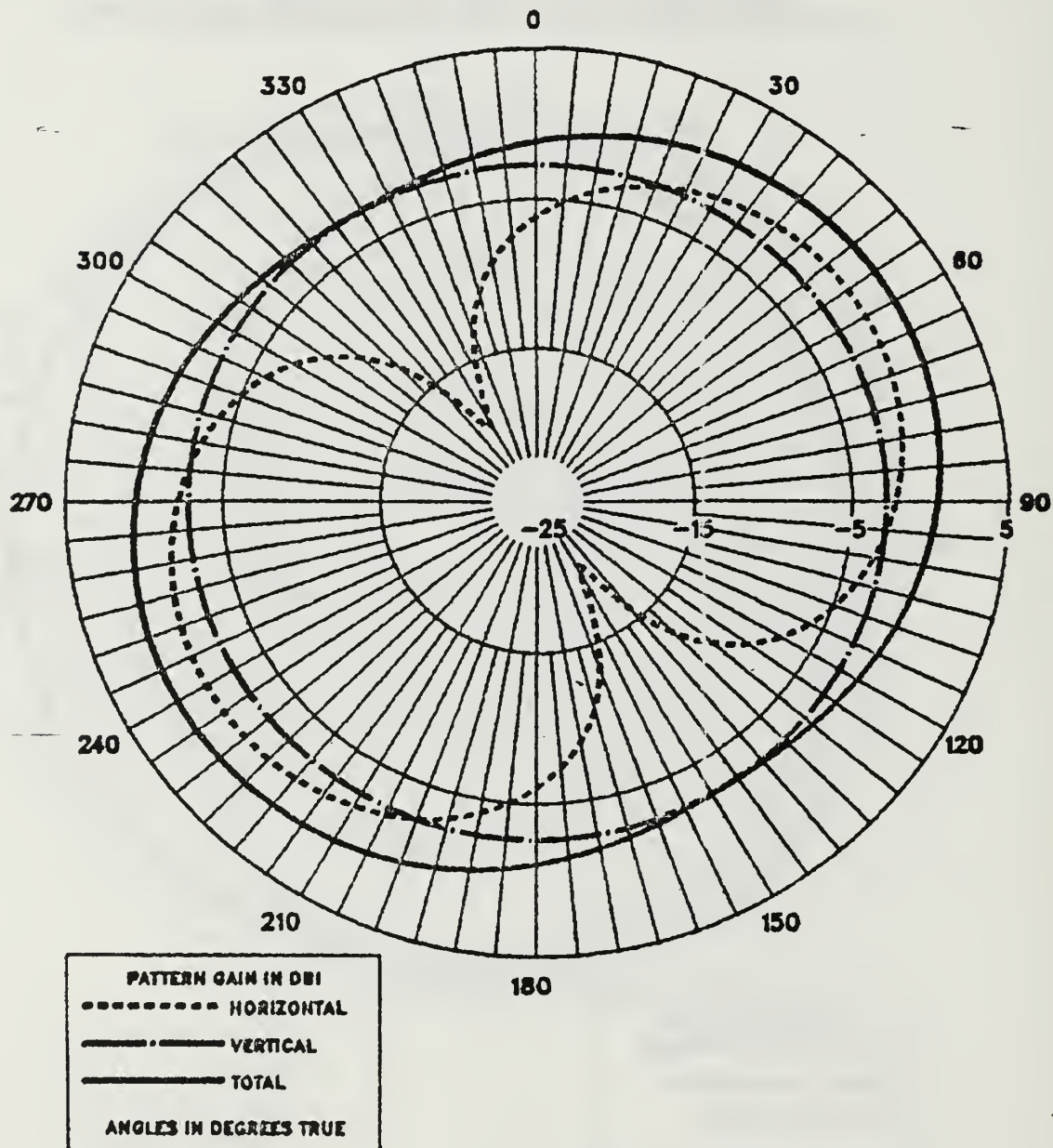
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LONG-WIRE ANT, FREE SPACE, VERT CUT, $\Phi=45$



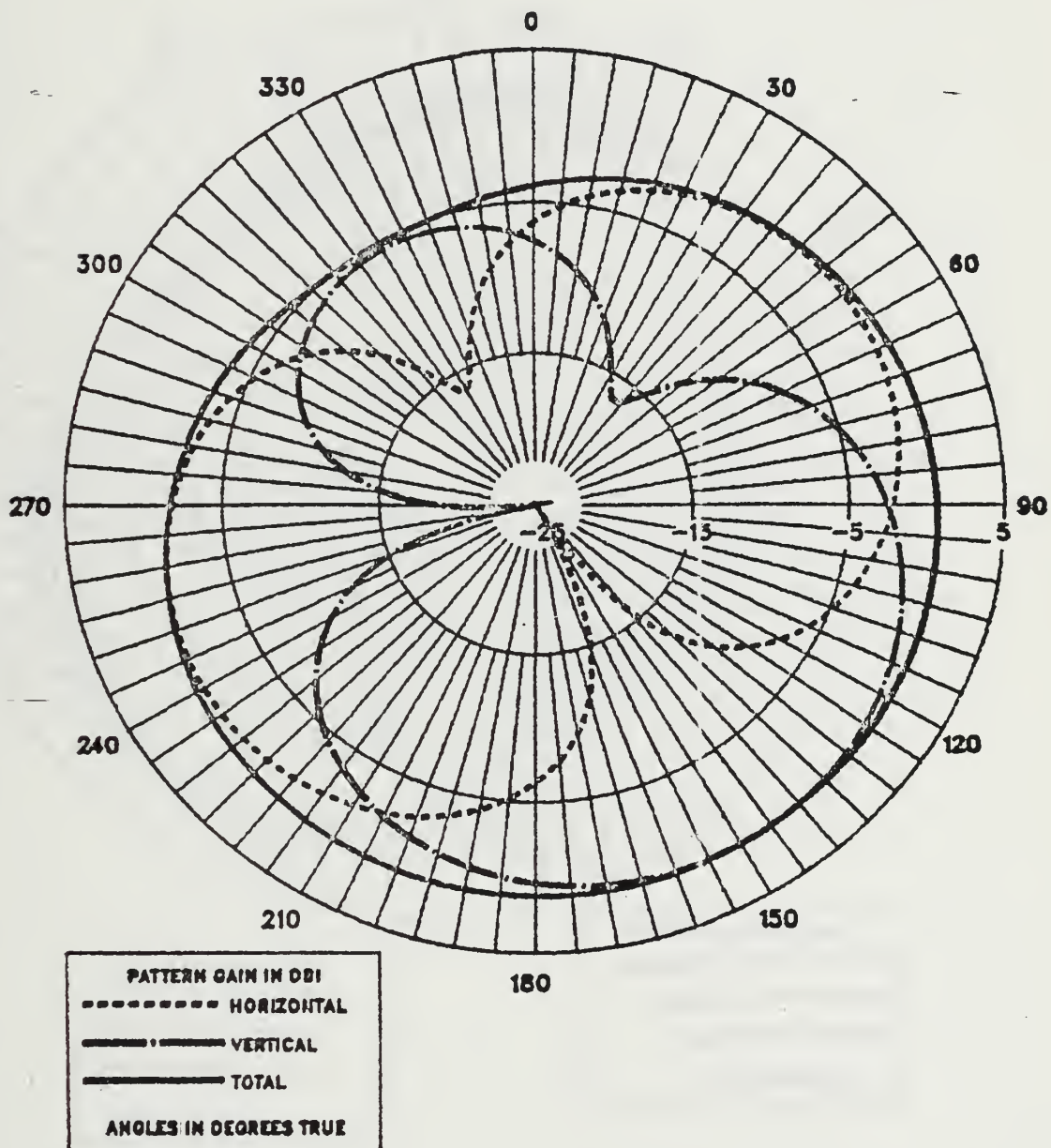
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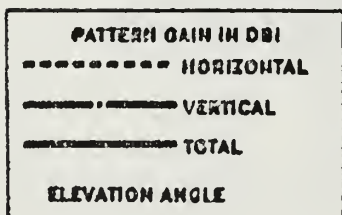
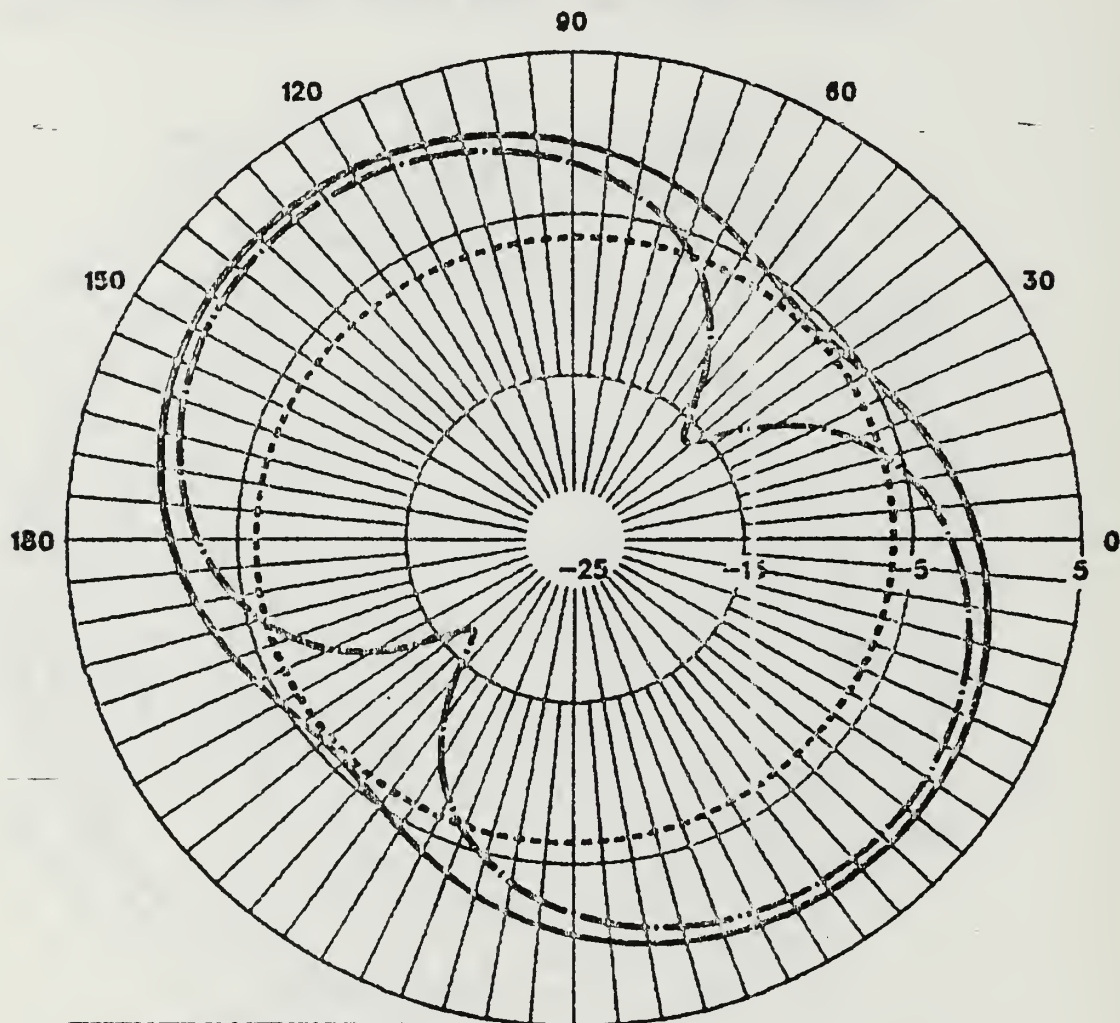
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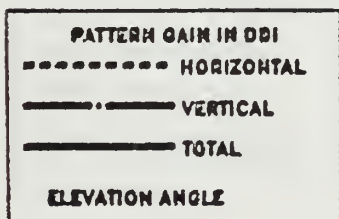
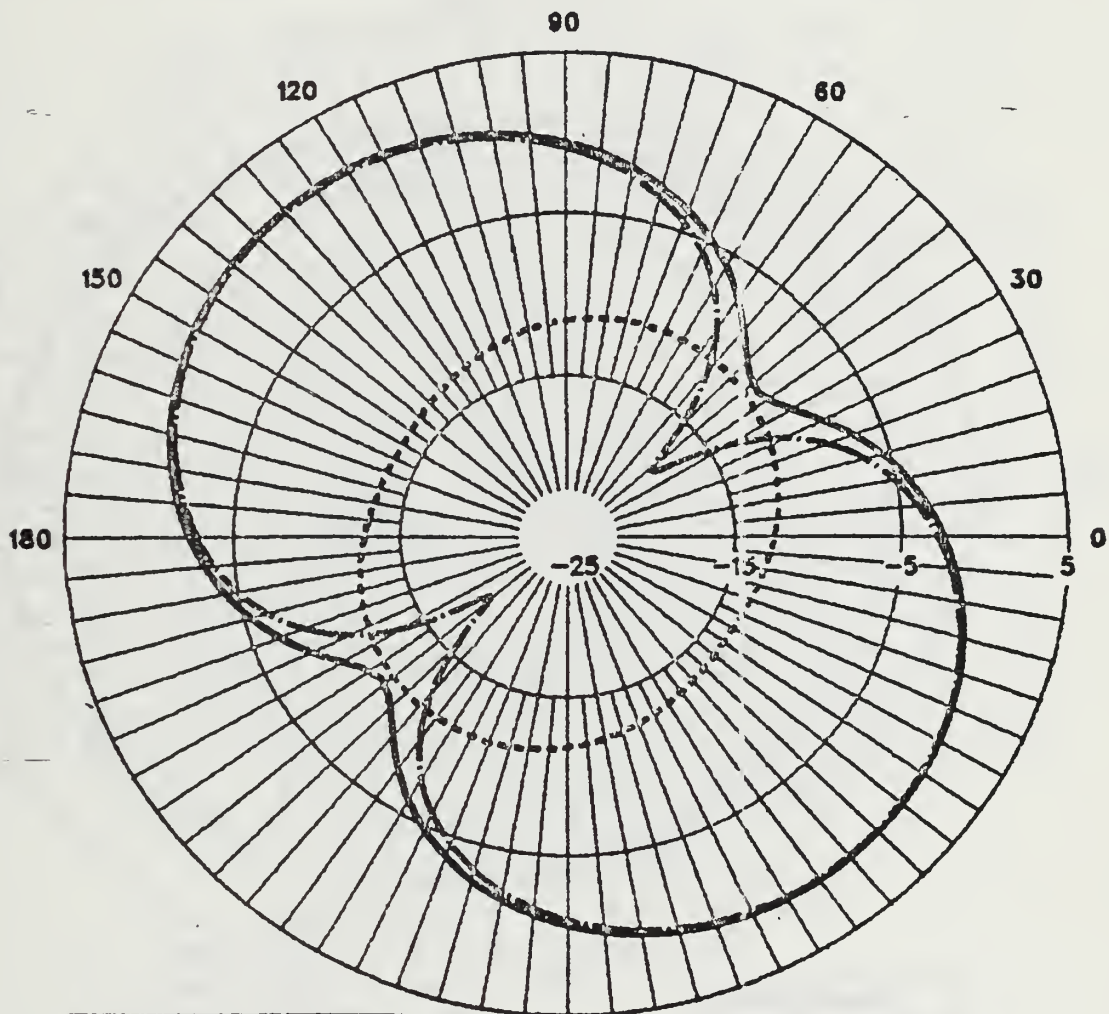
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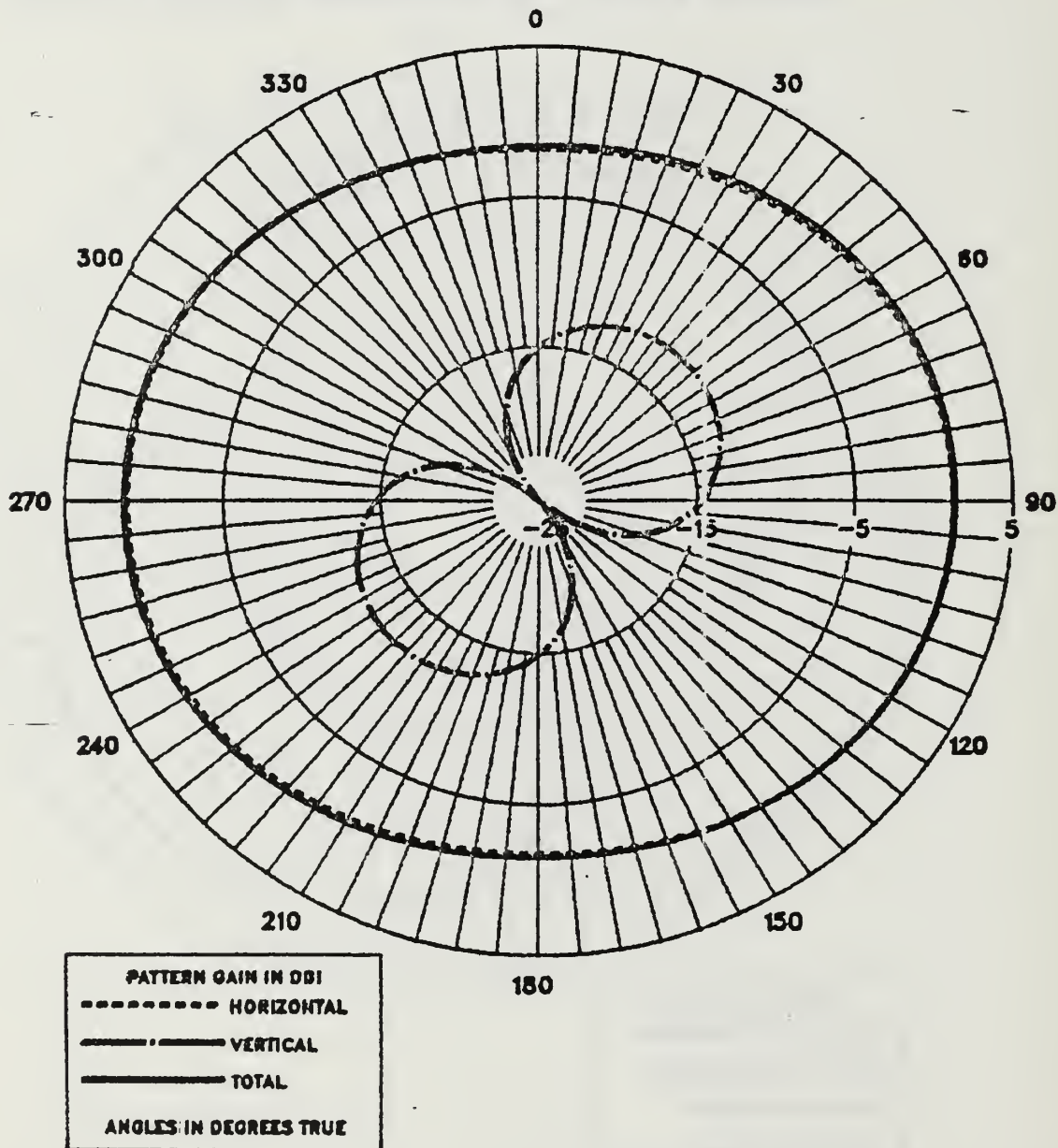
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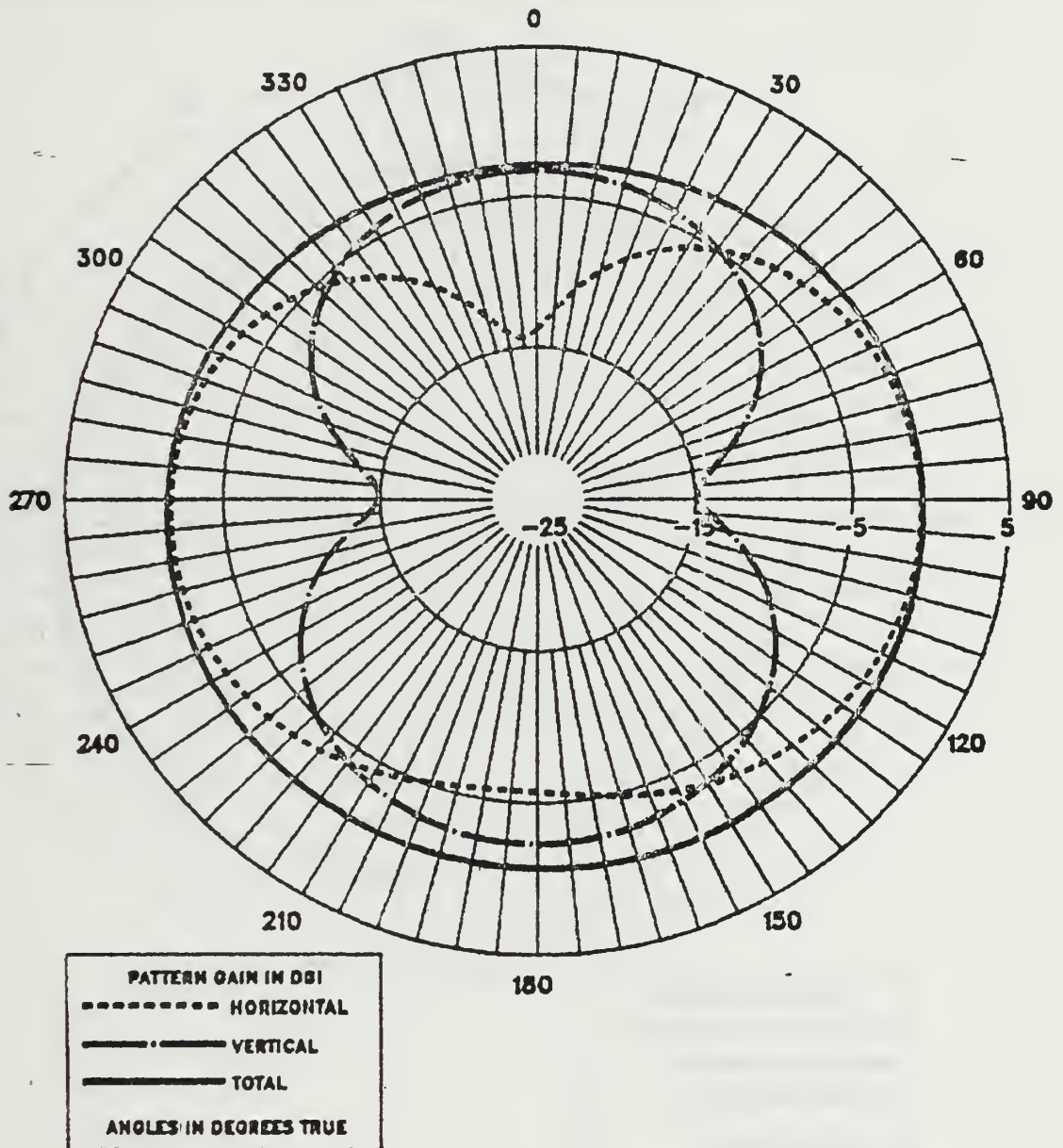
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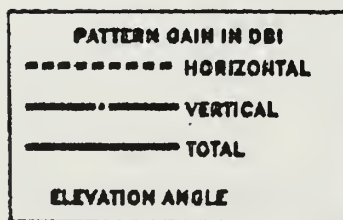
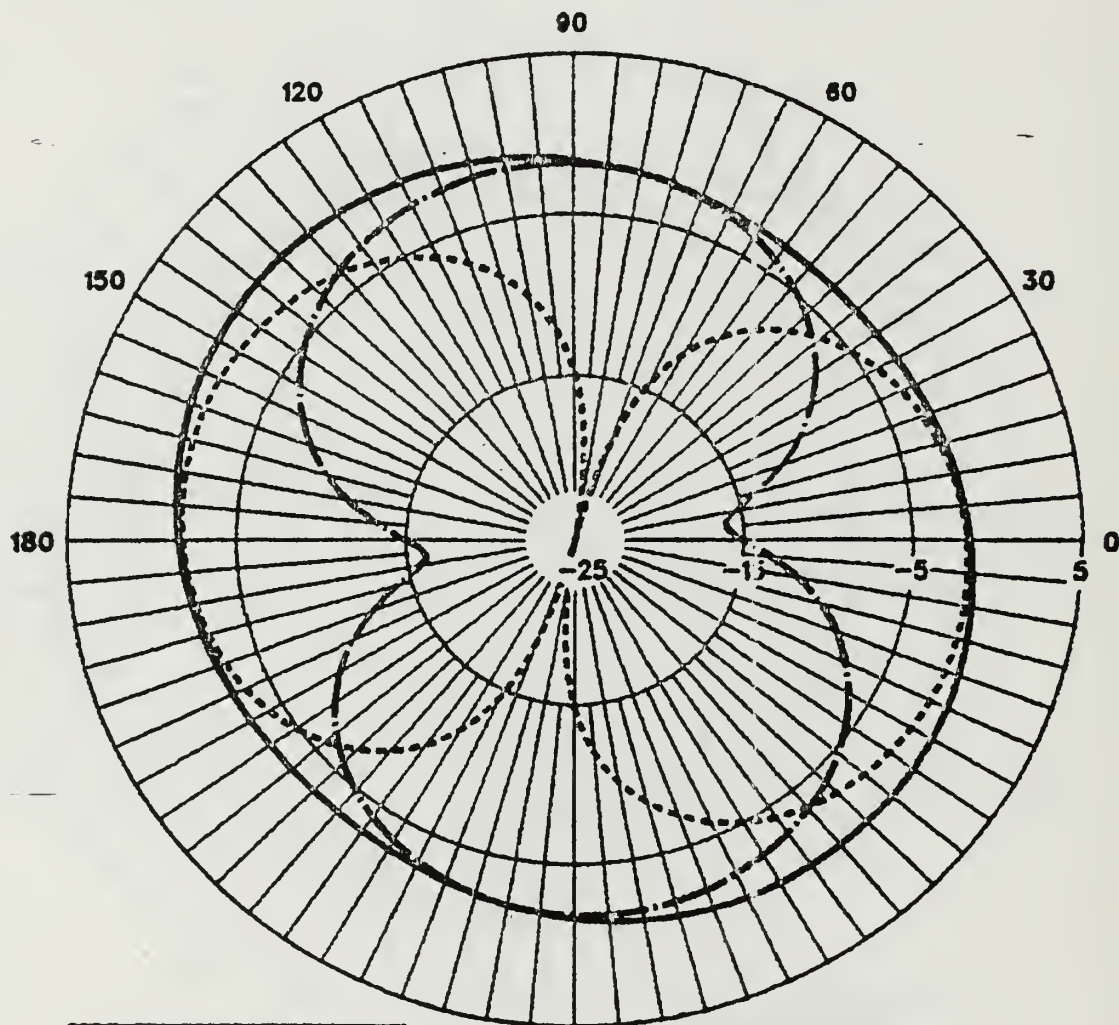
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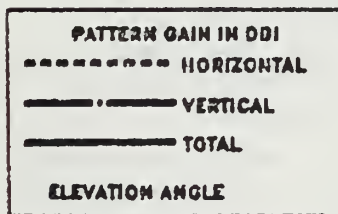
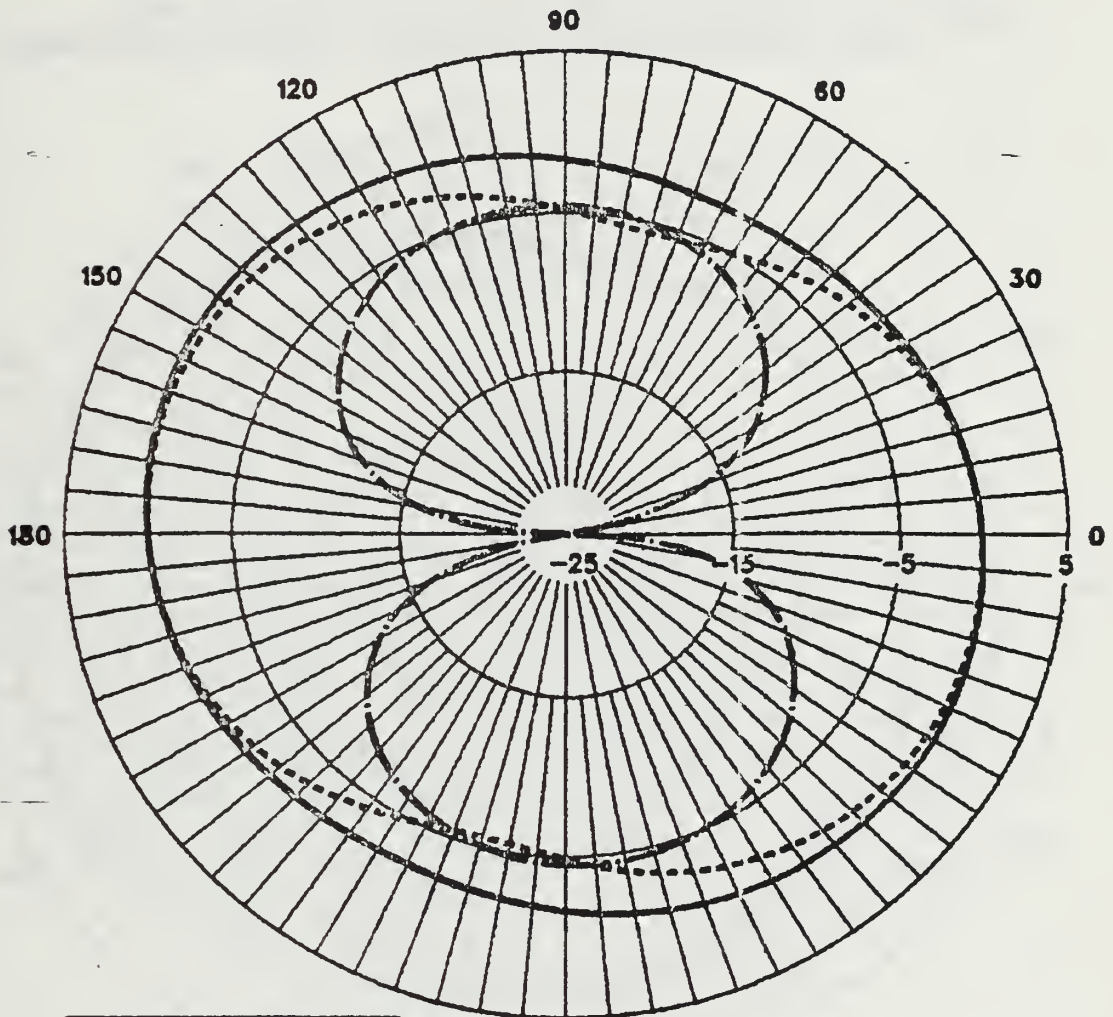
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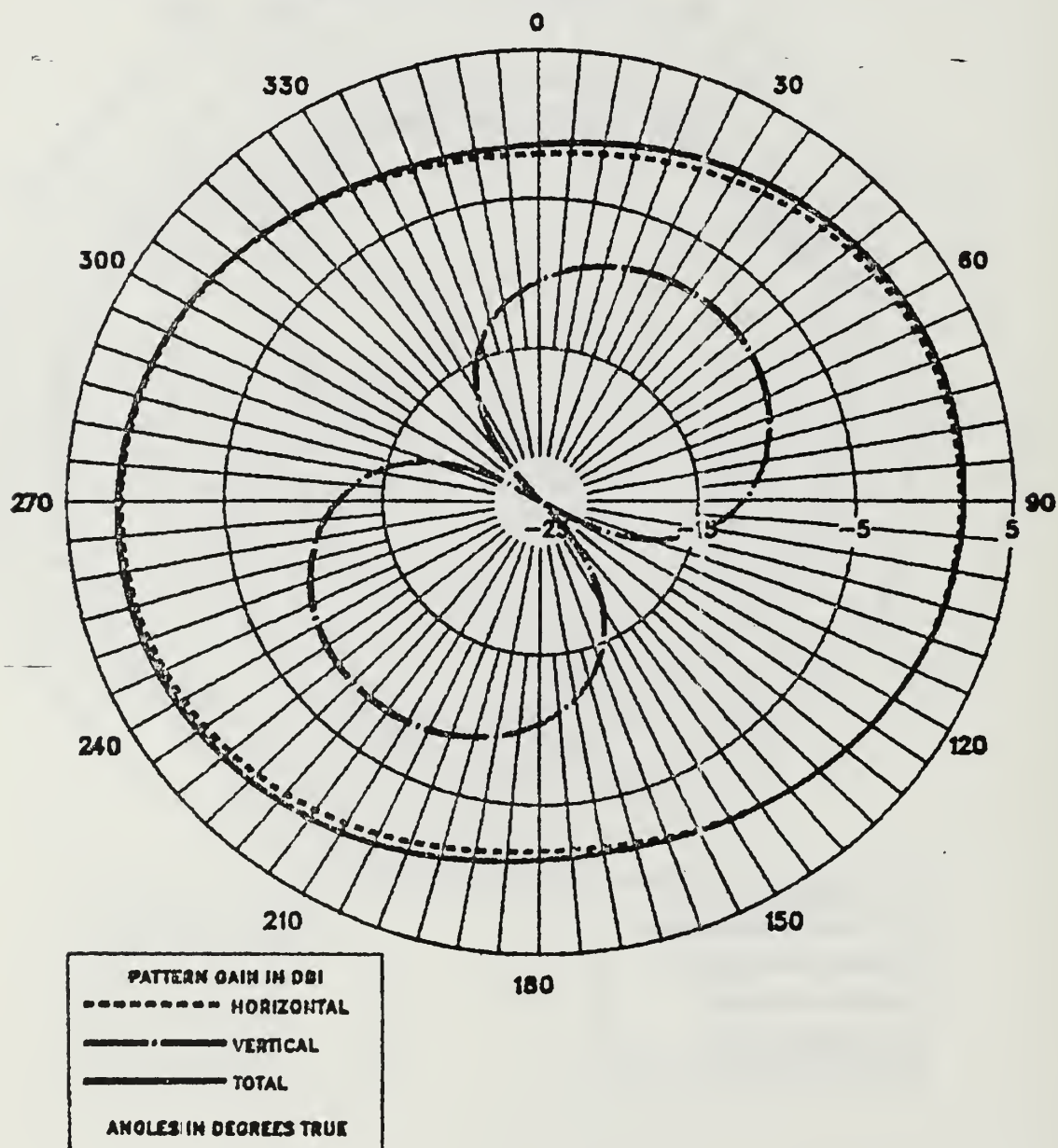
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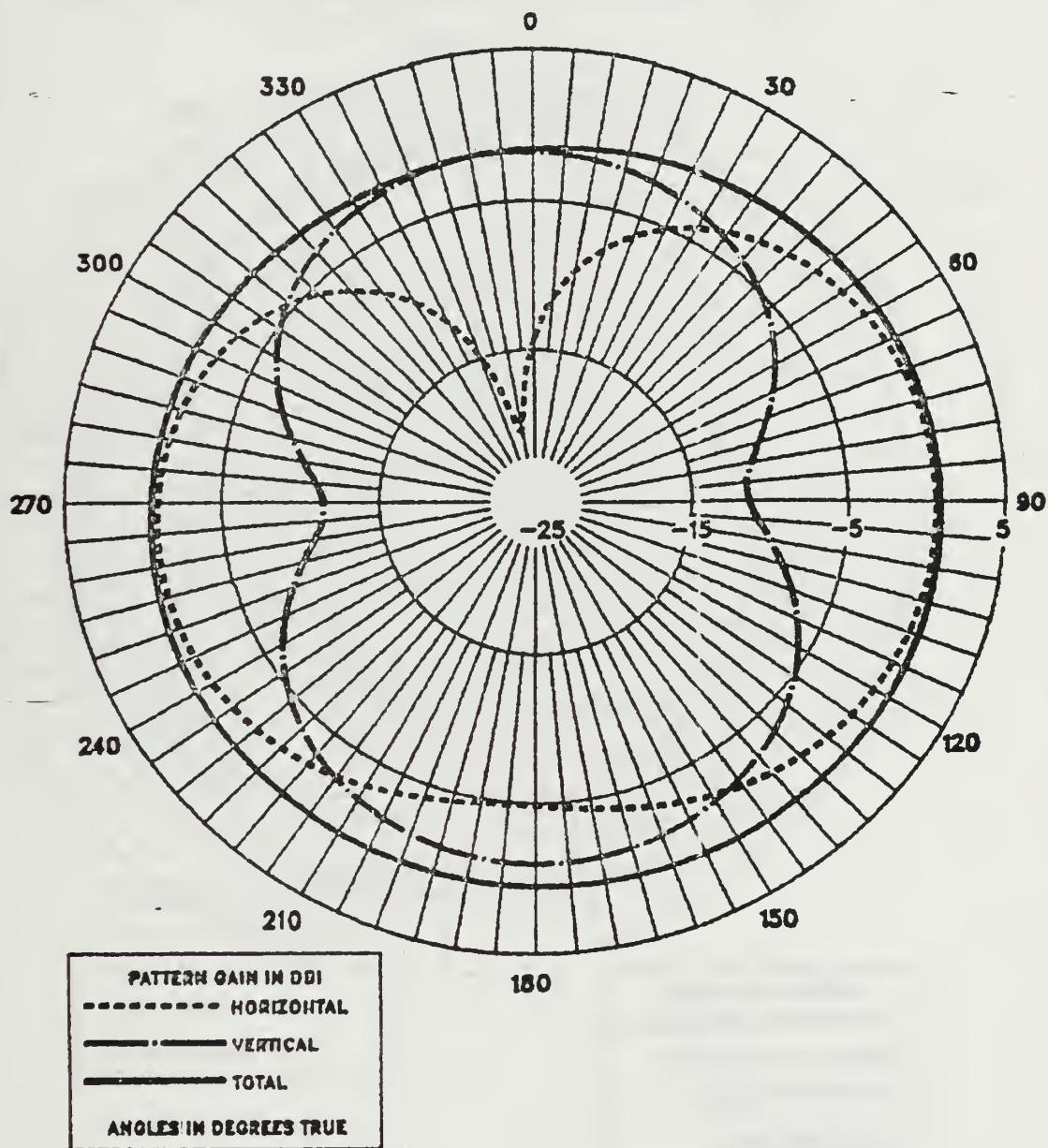
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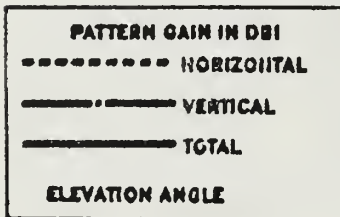
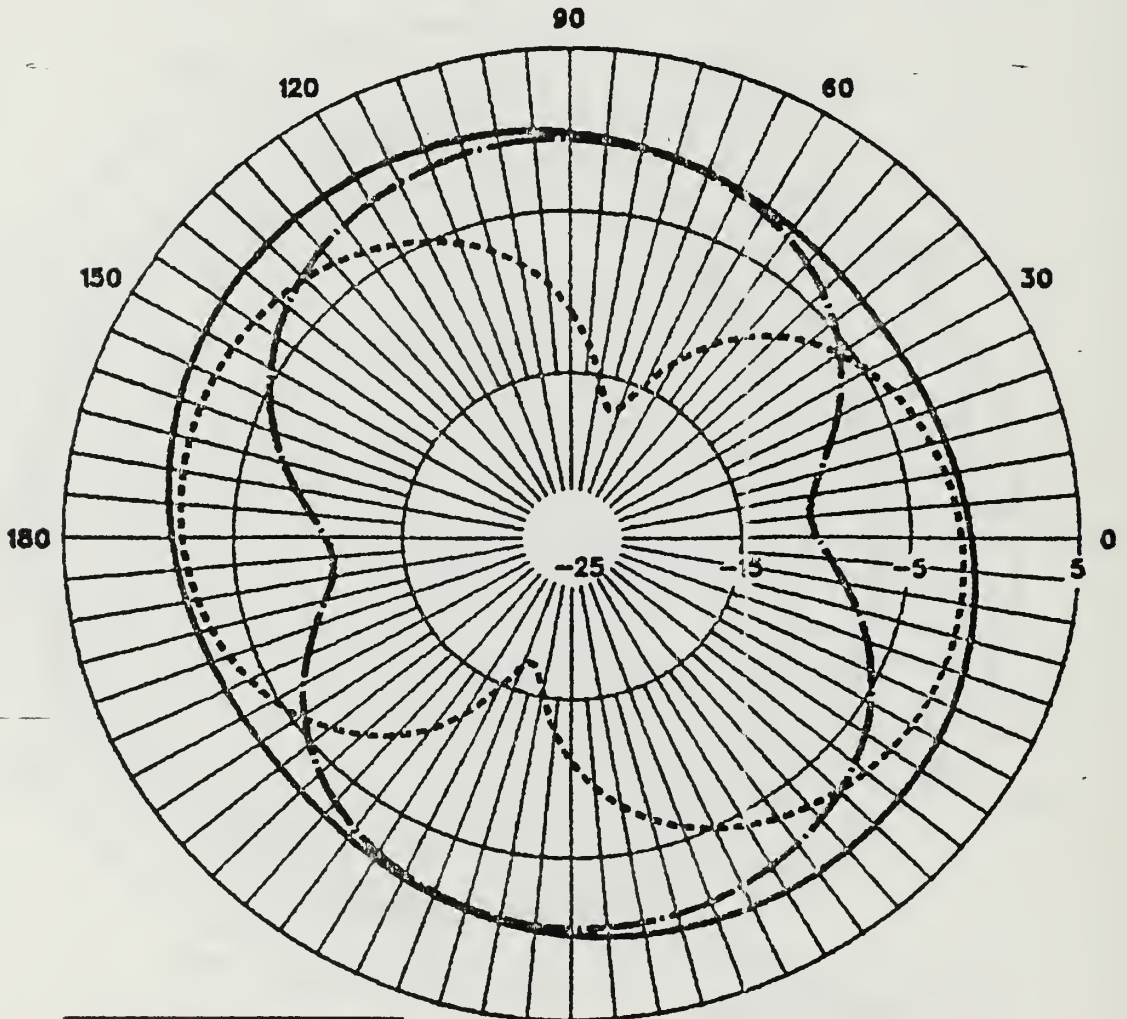
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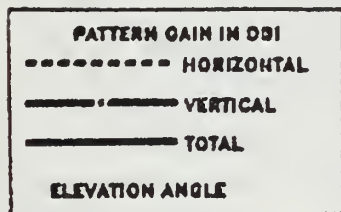
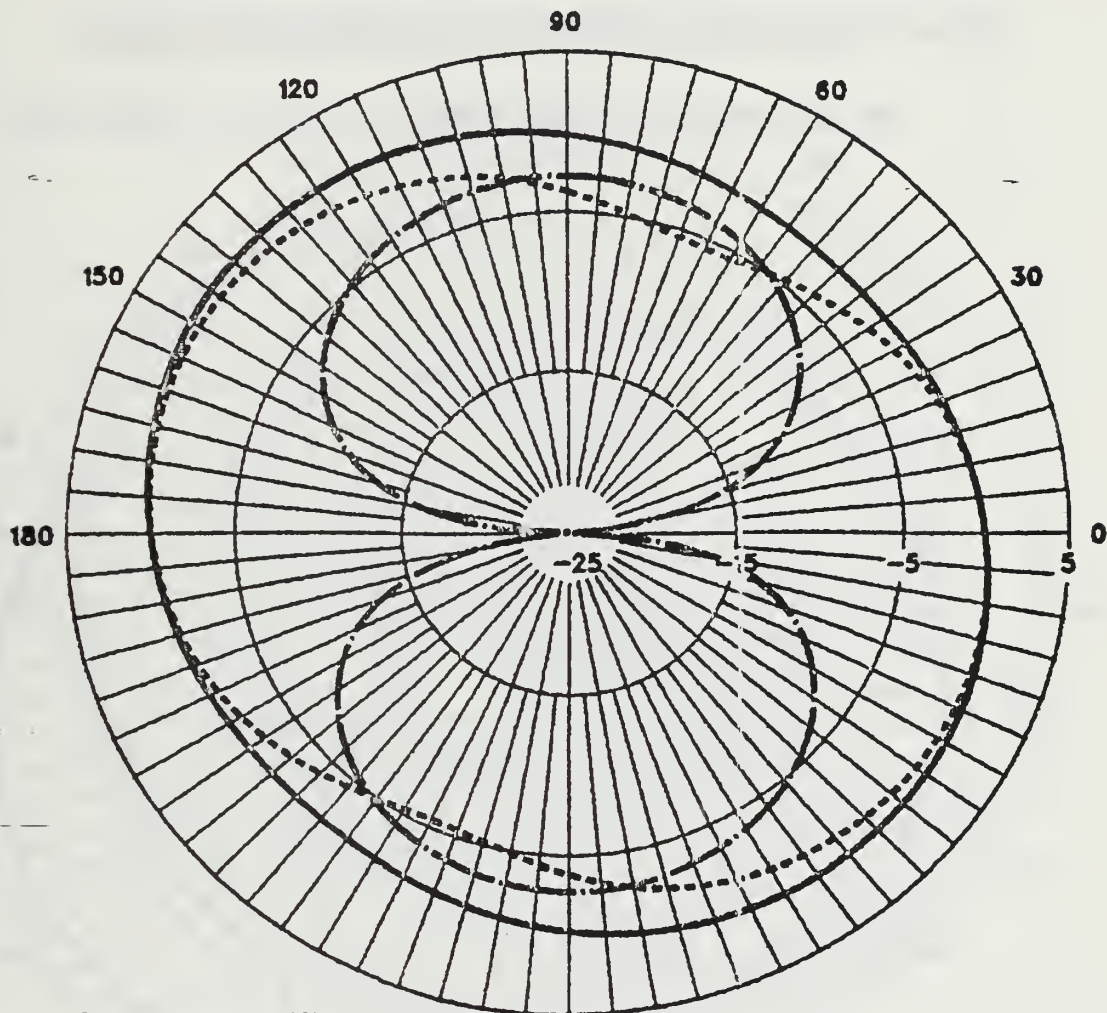
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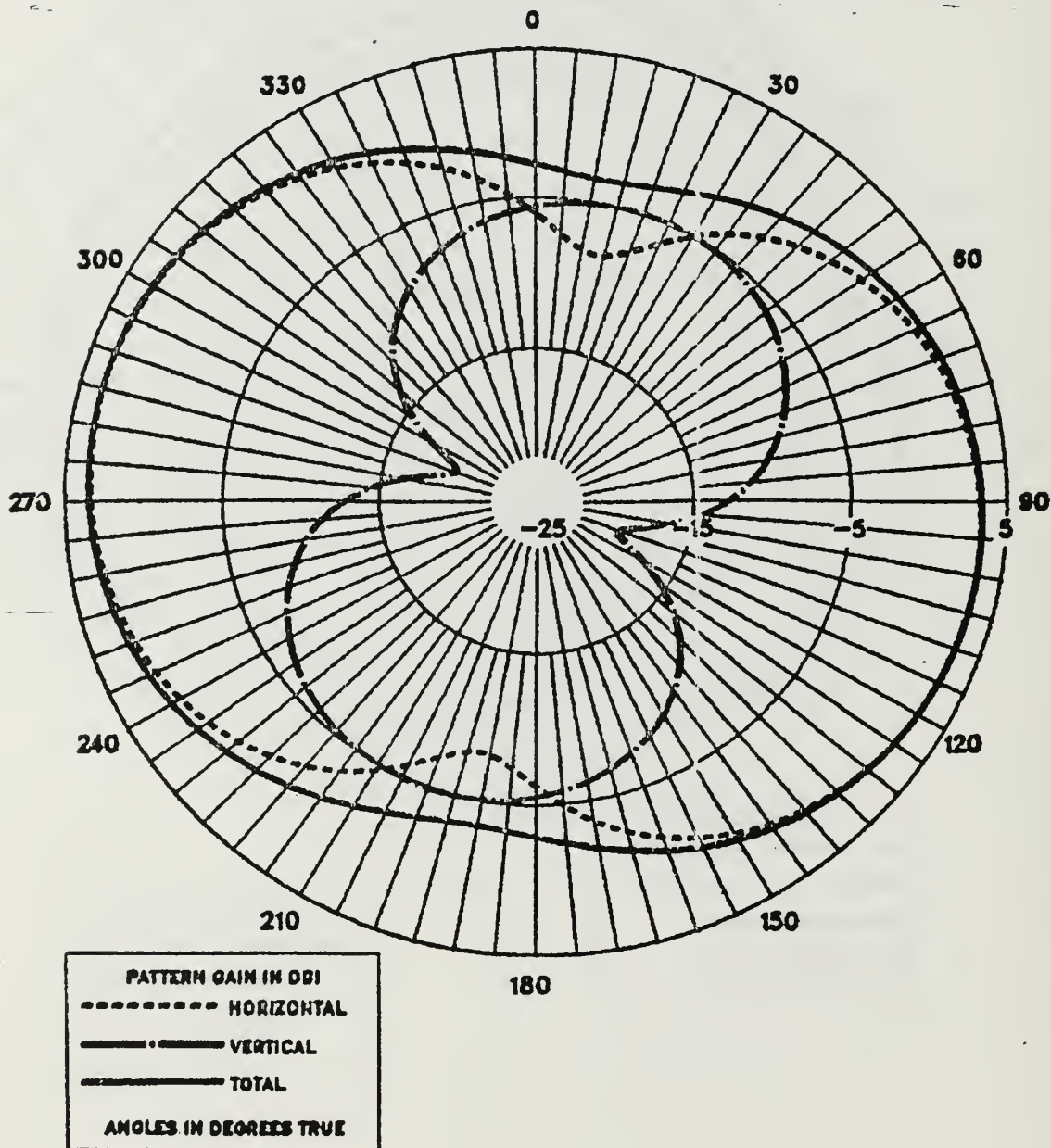
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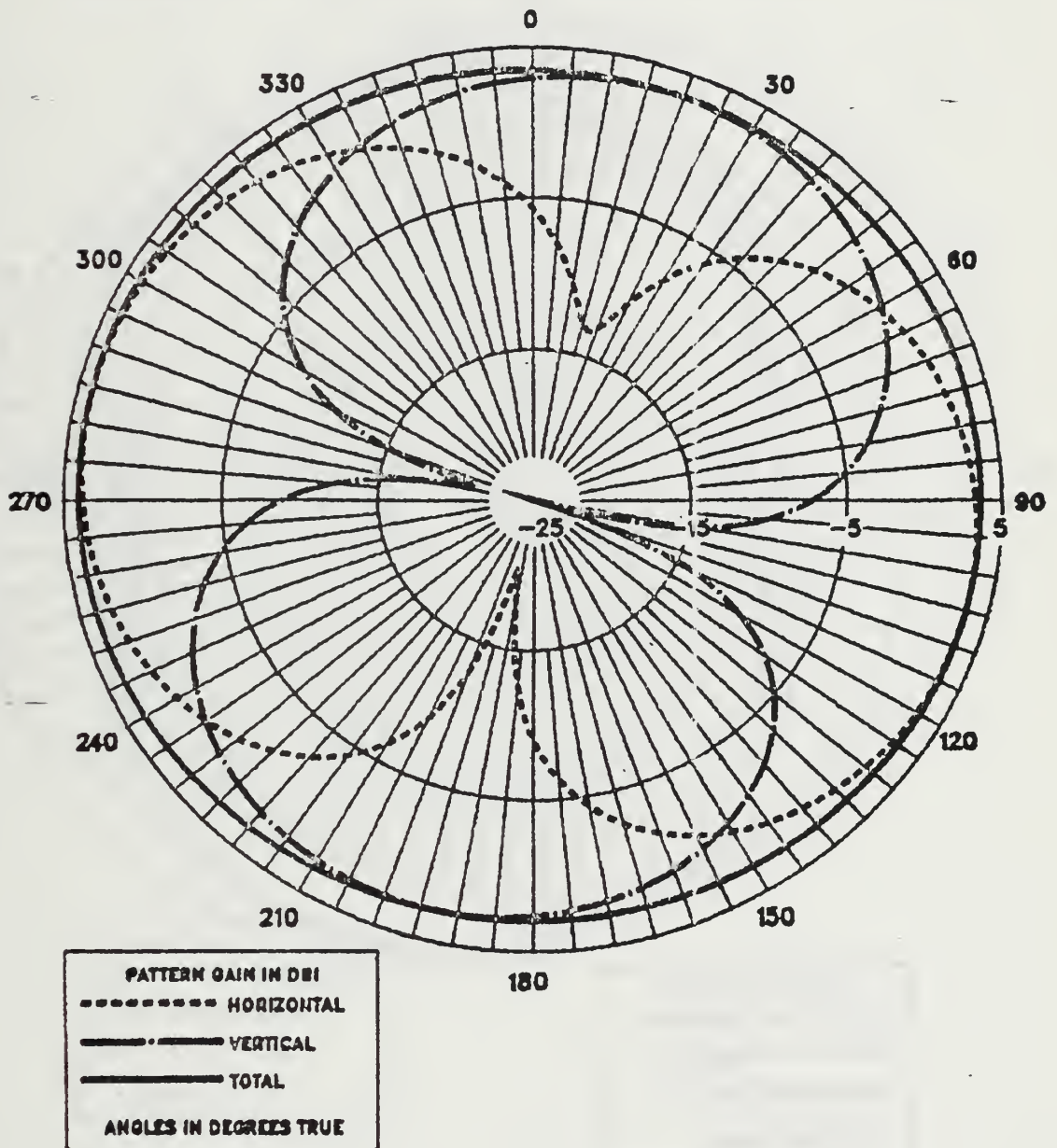
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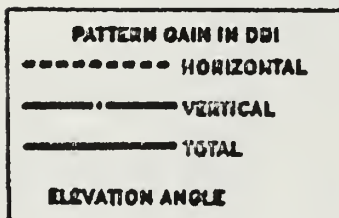
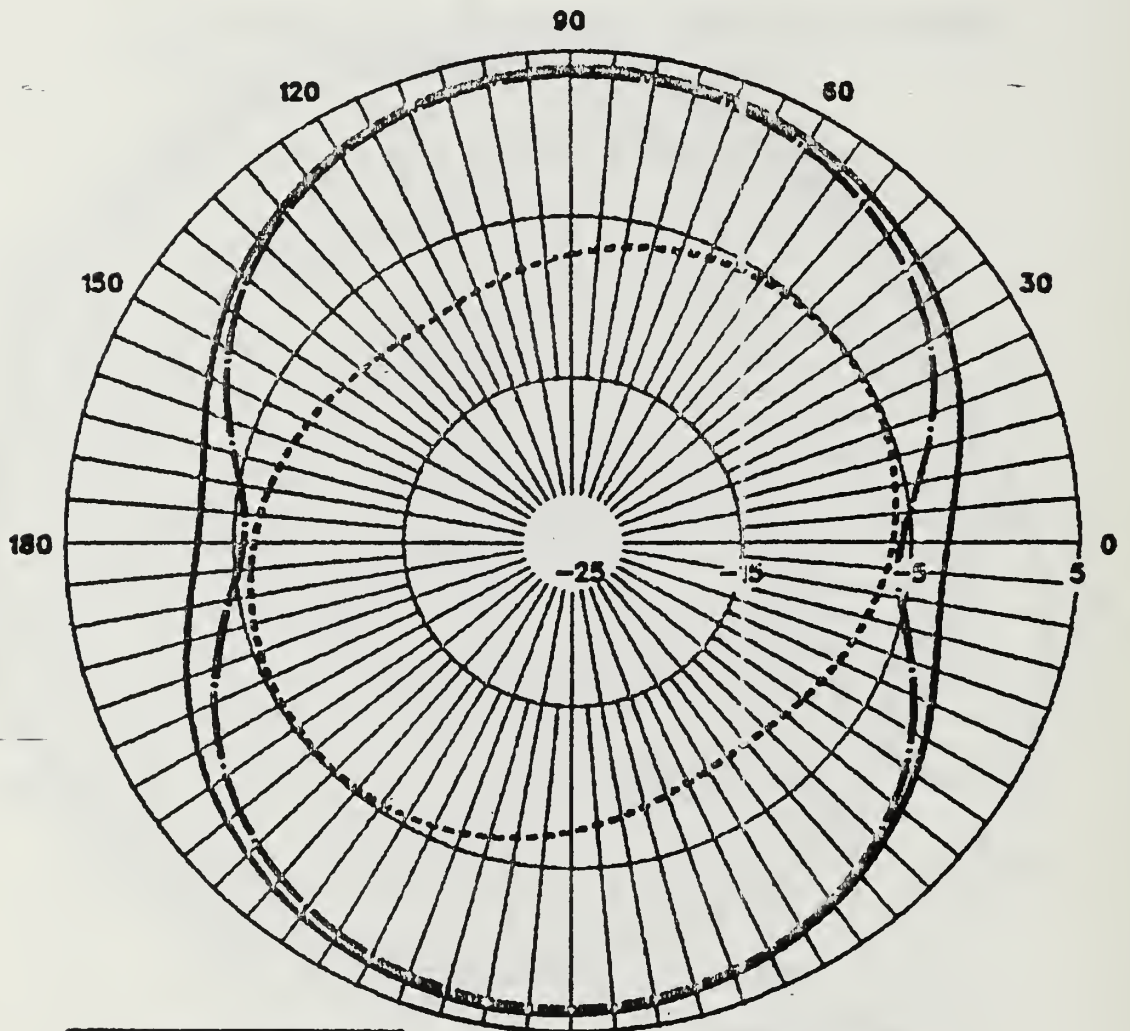
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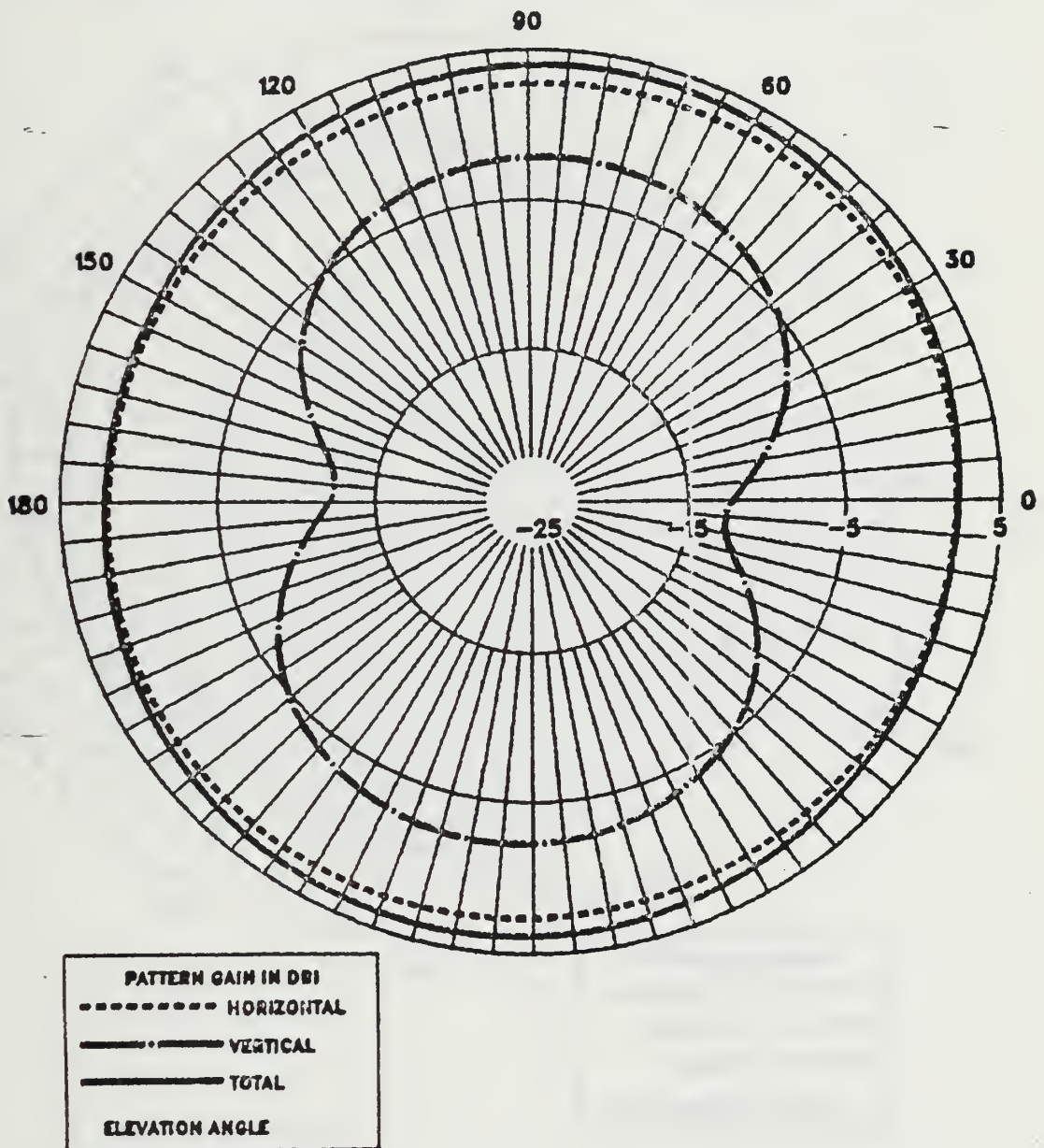
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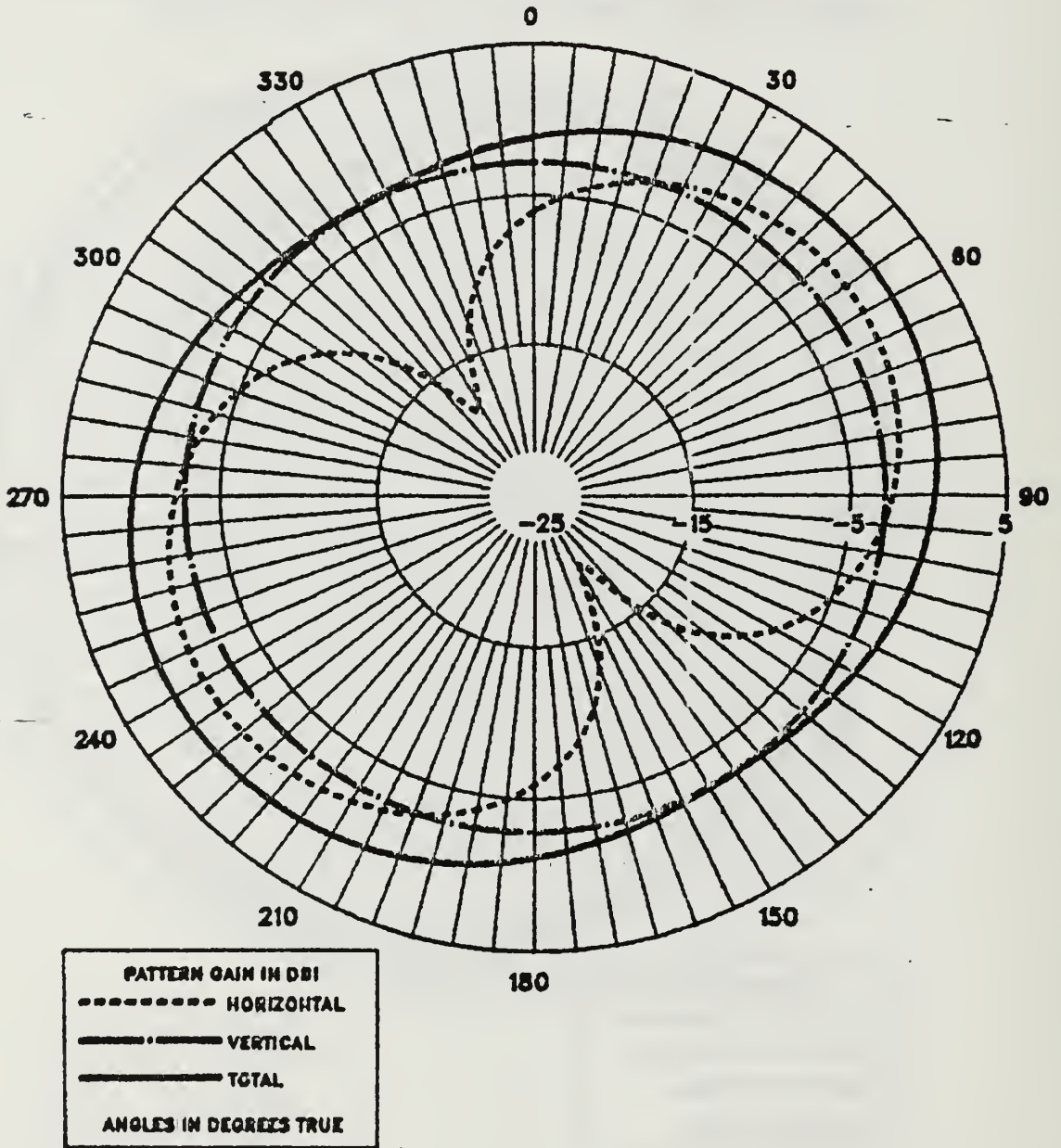
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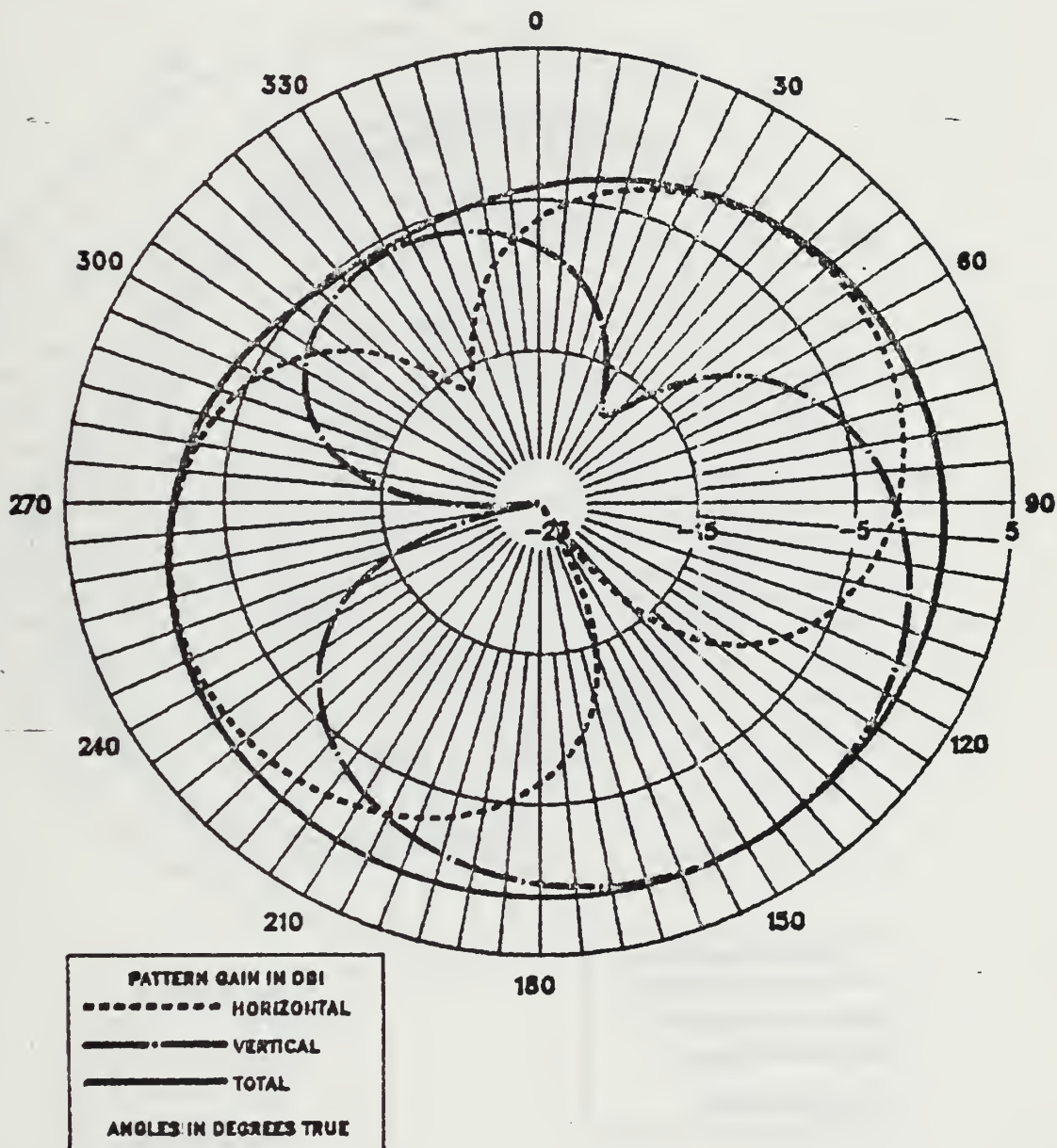
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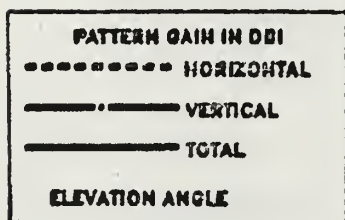
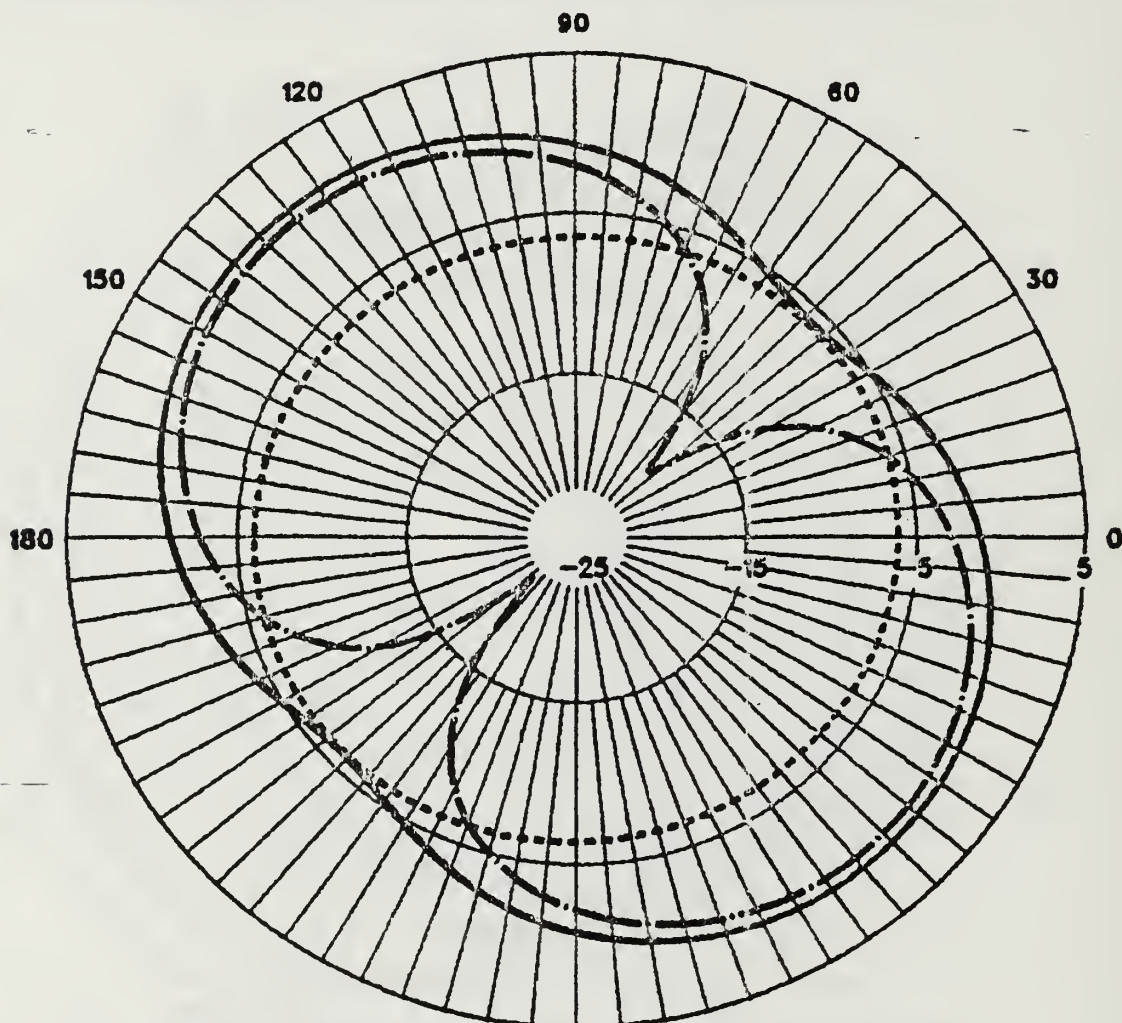
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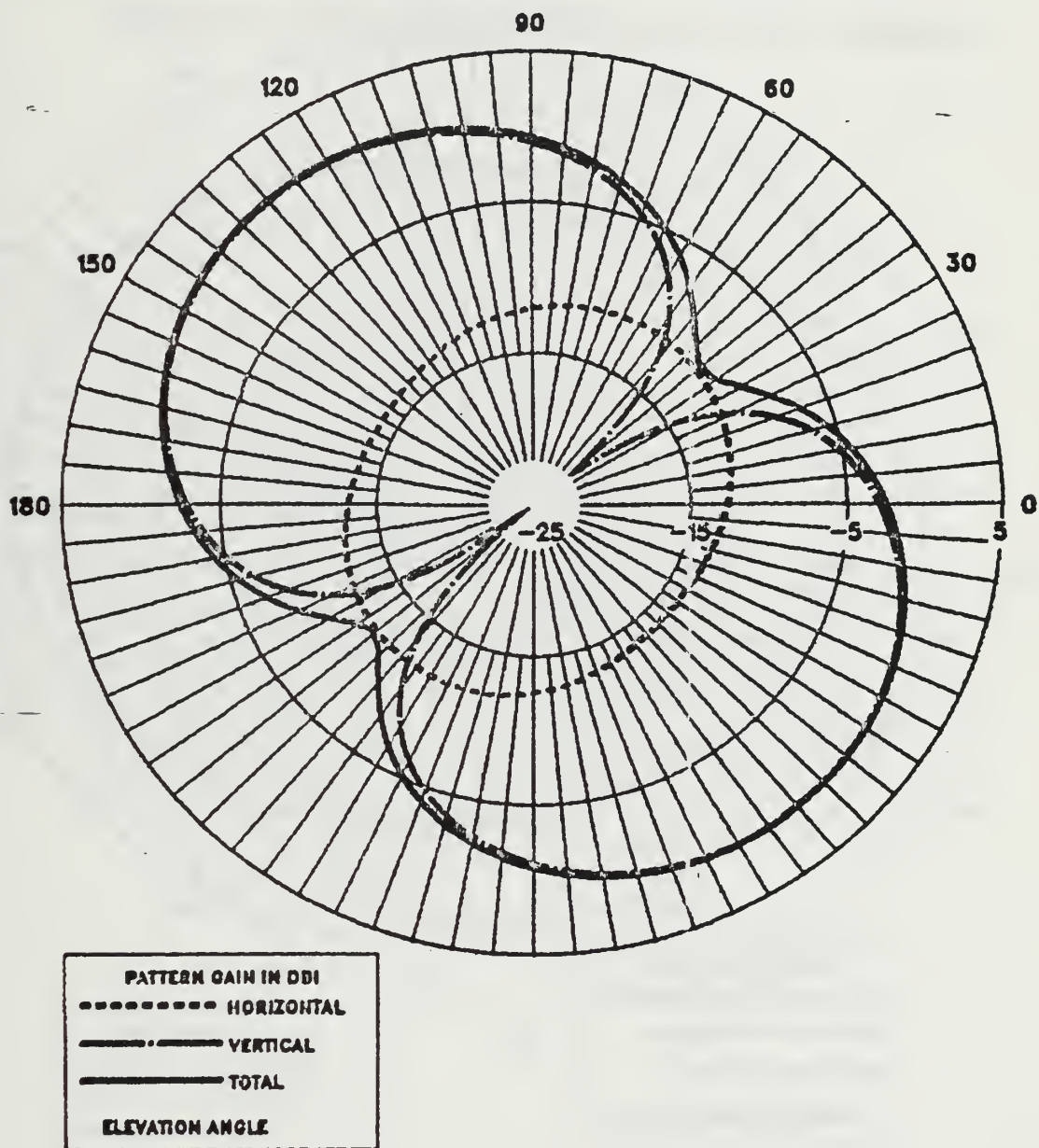
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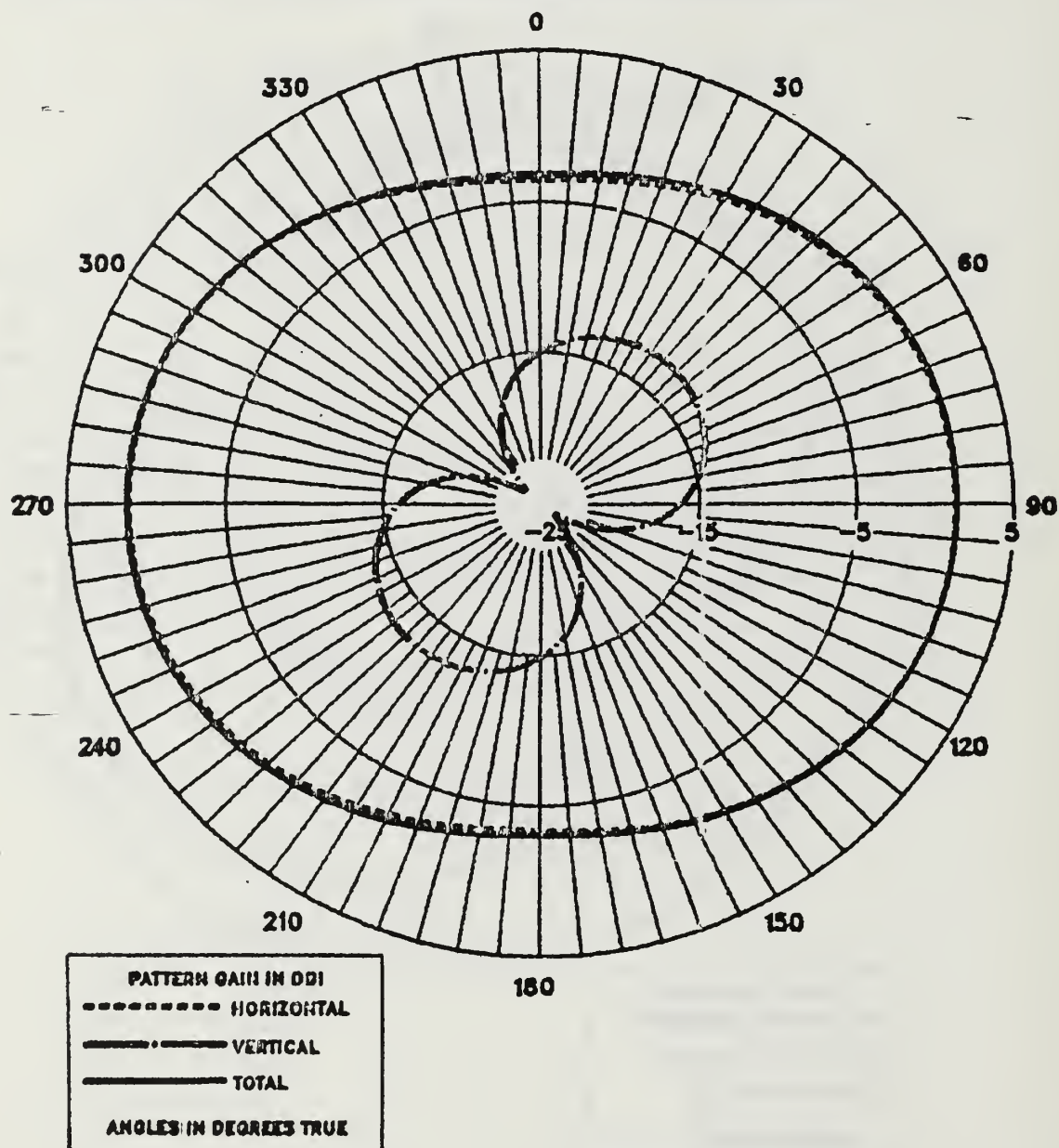
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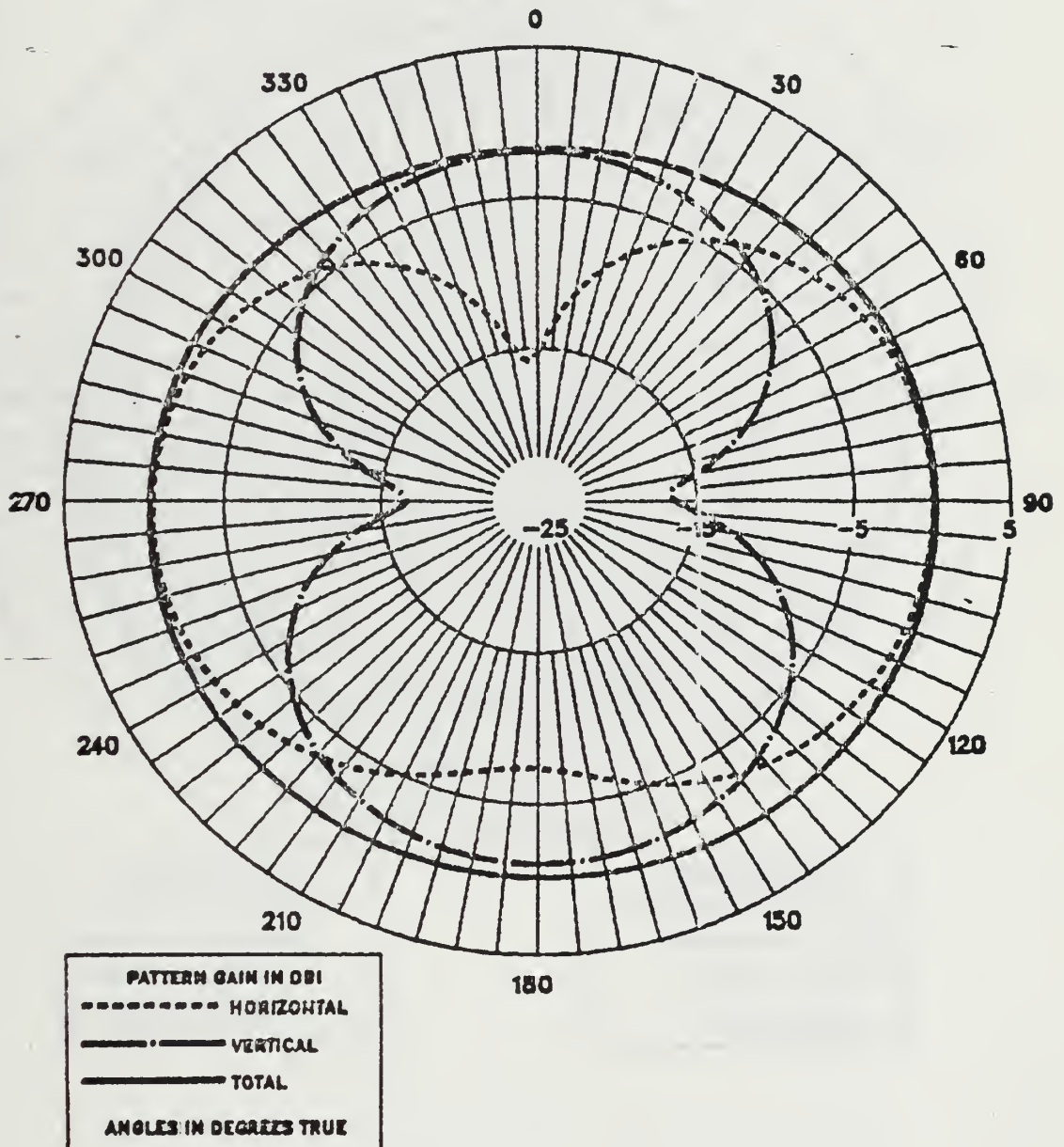
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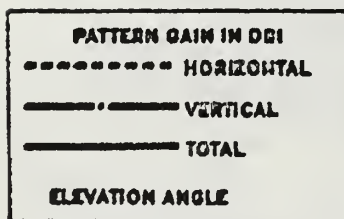
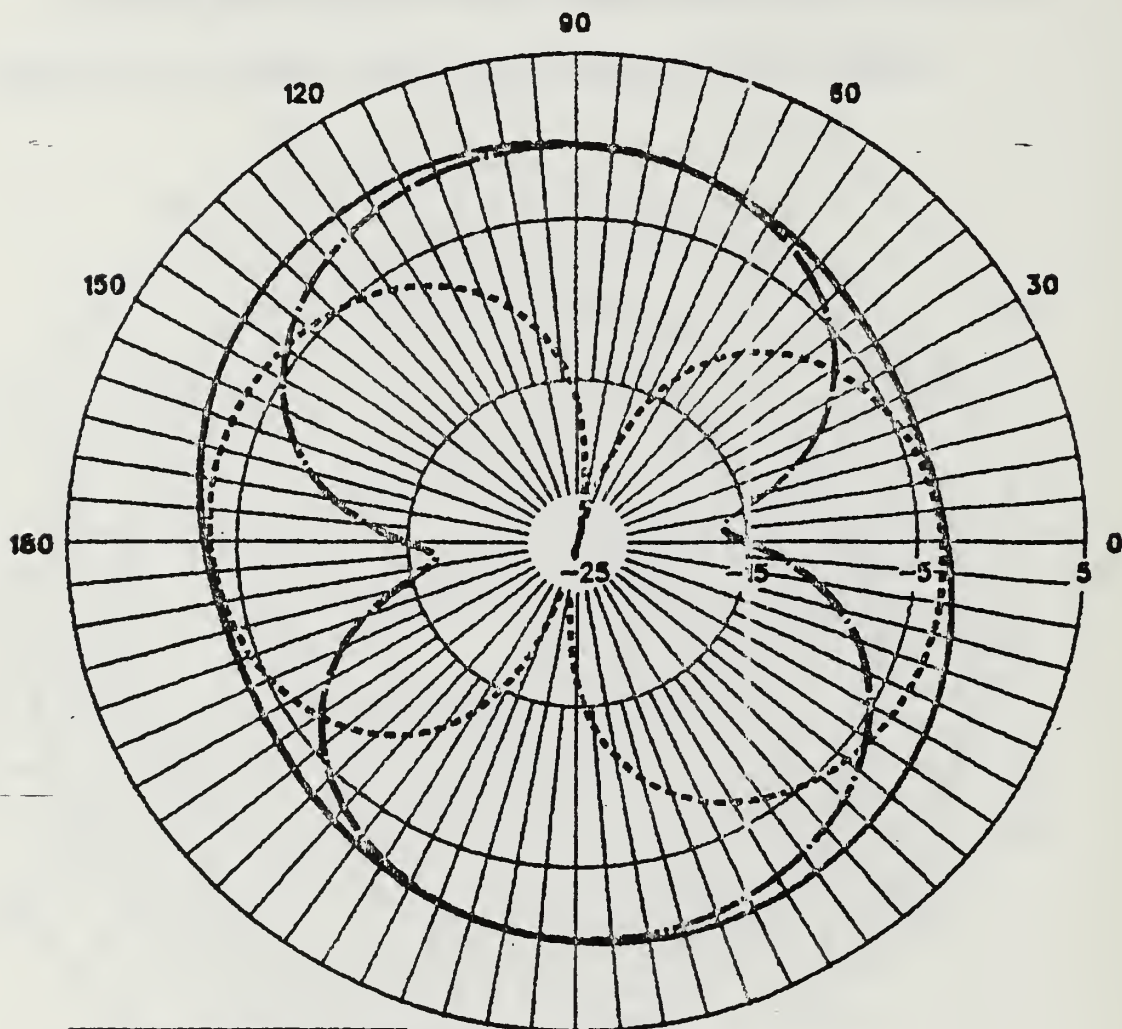
H65 IGUANA DATA RUN AT 4.040MHZ ON 8/15/87

ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CUT, THETA=26



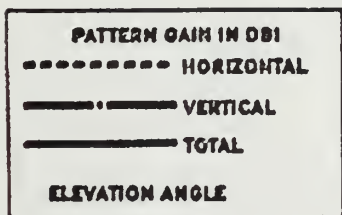
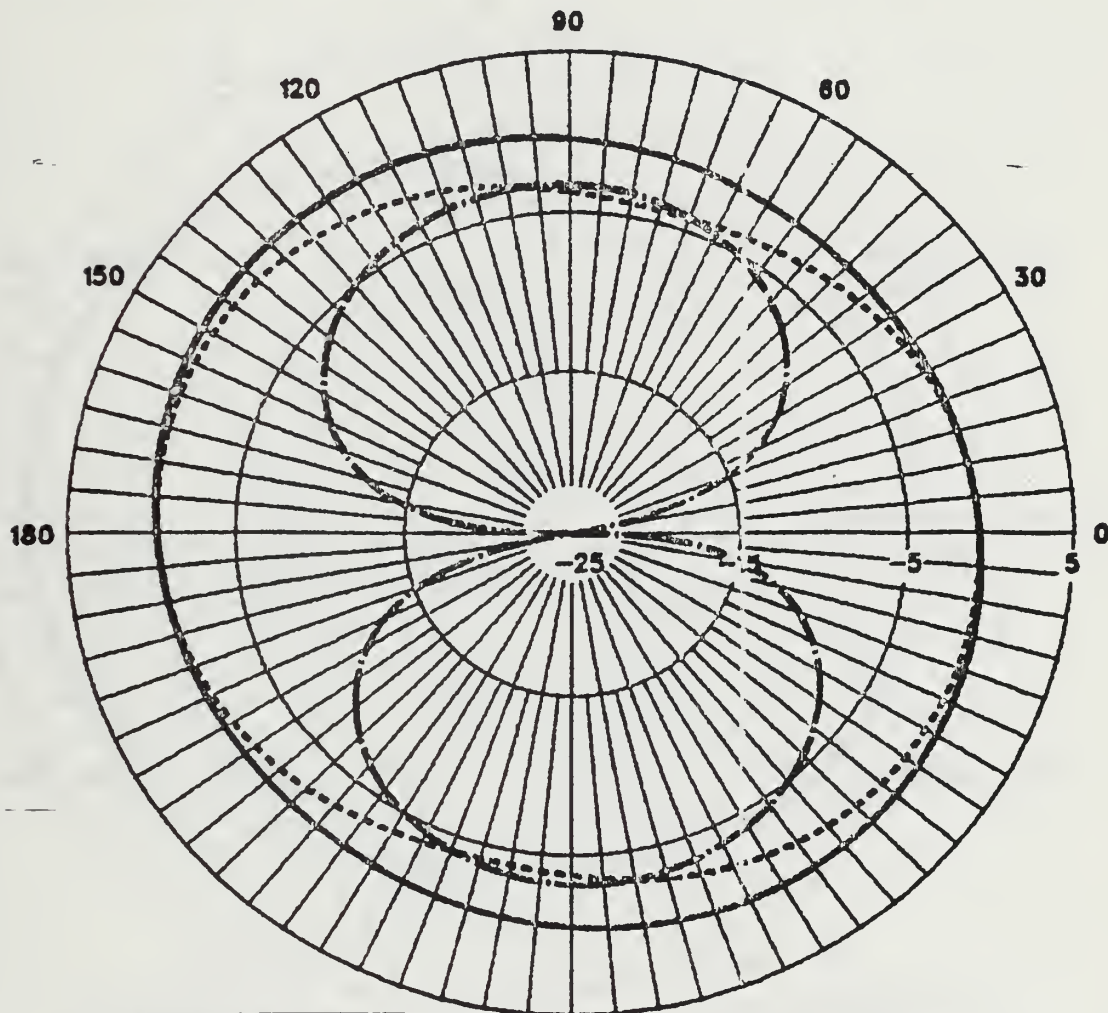
H65 IGUANA DATA RUN AT 4.040MHZ ON 8/15/87

ARMY-TYPE TUBE ANT, FREE SPACE, VERT CUT, PHI=0



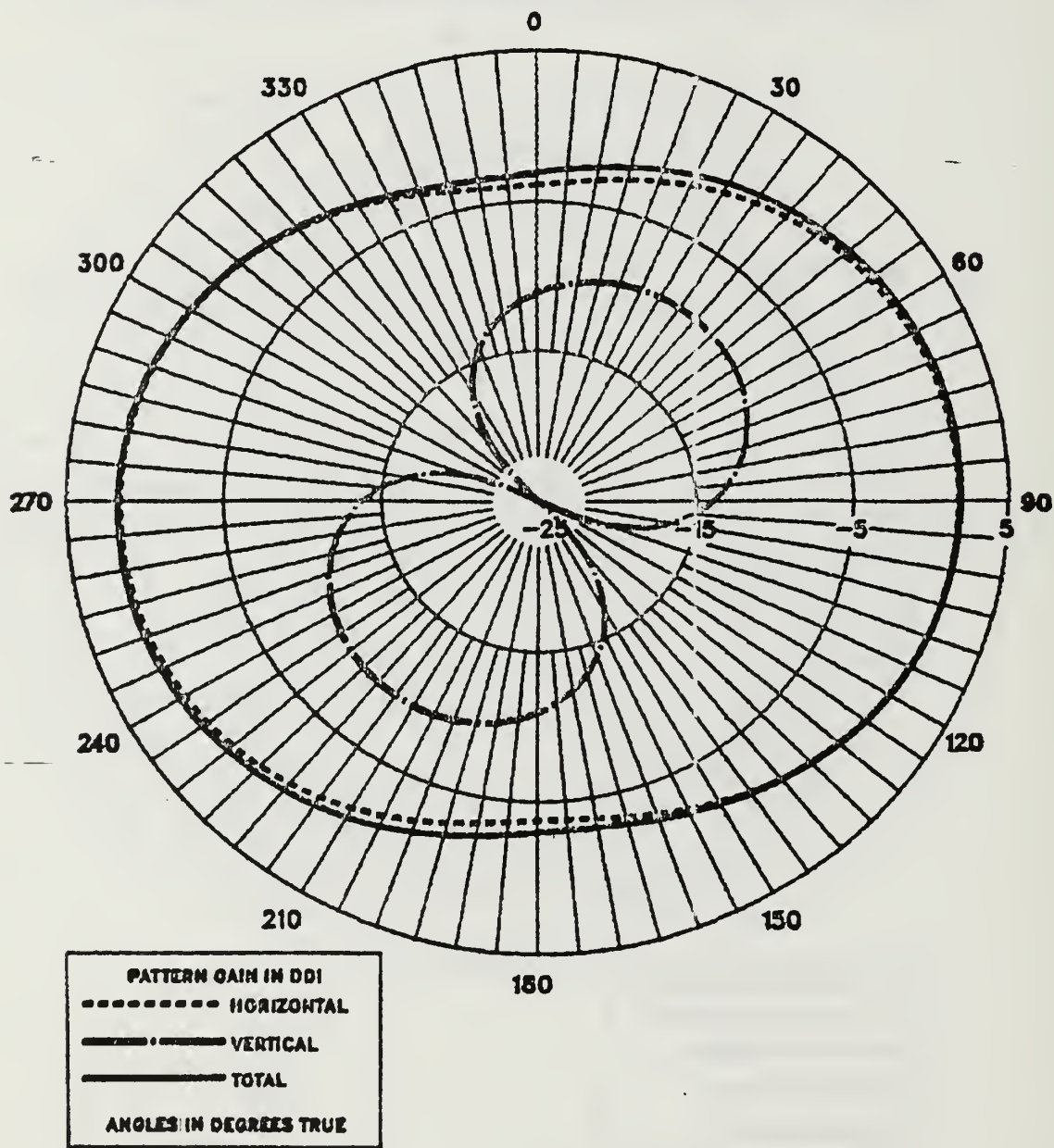
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ARMY-TYPE TUBE ANT, FREE SPACE, VERT CUT, PHI=45



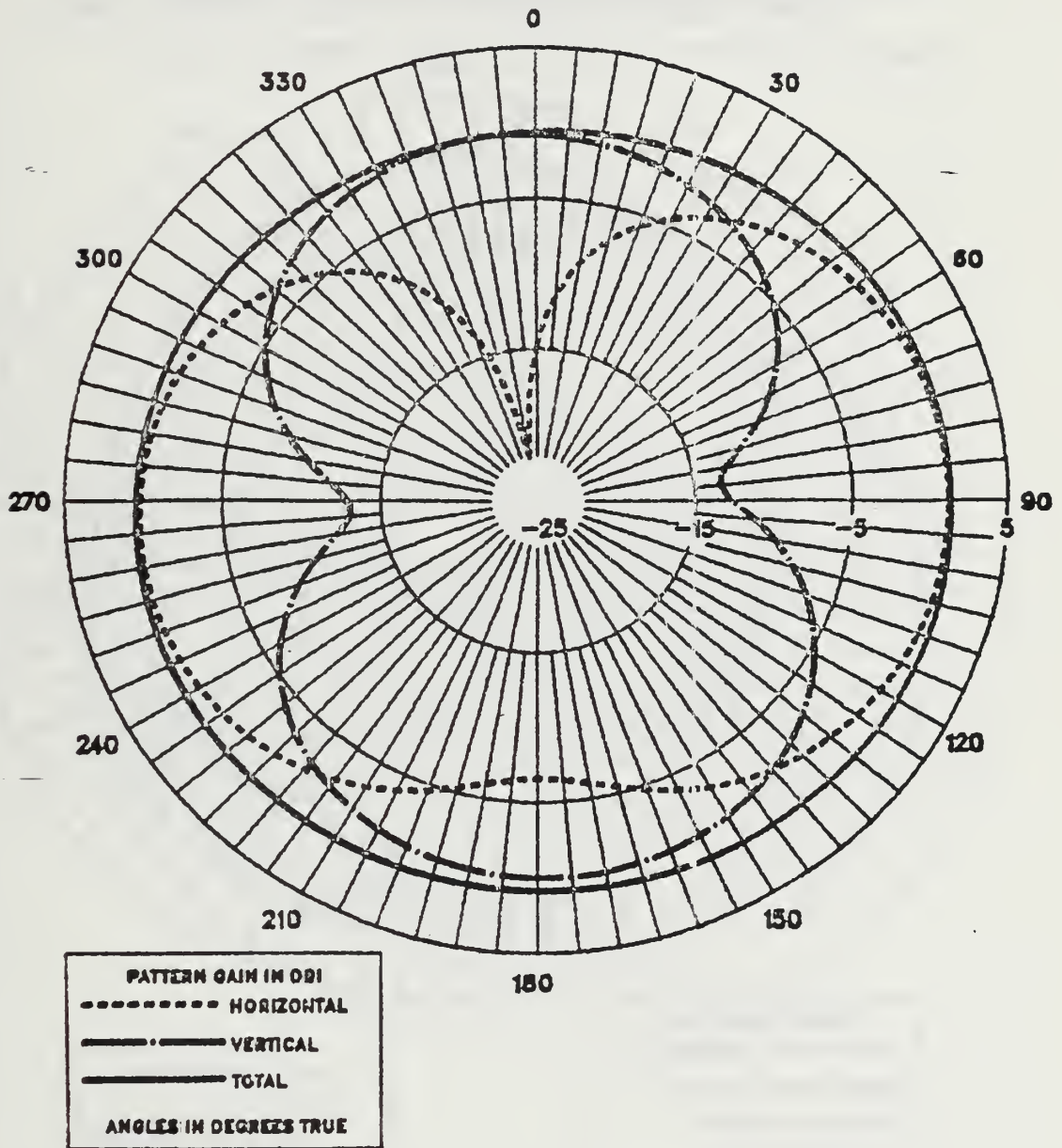
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LONG SHUNTED LOOP, FREE SPACE, HORIZ CUT, THETA=90



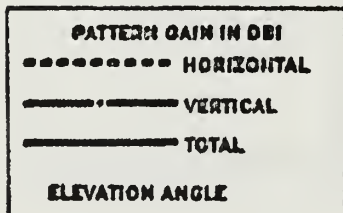
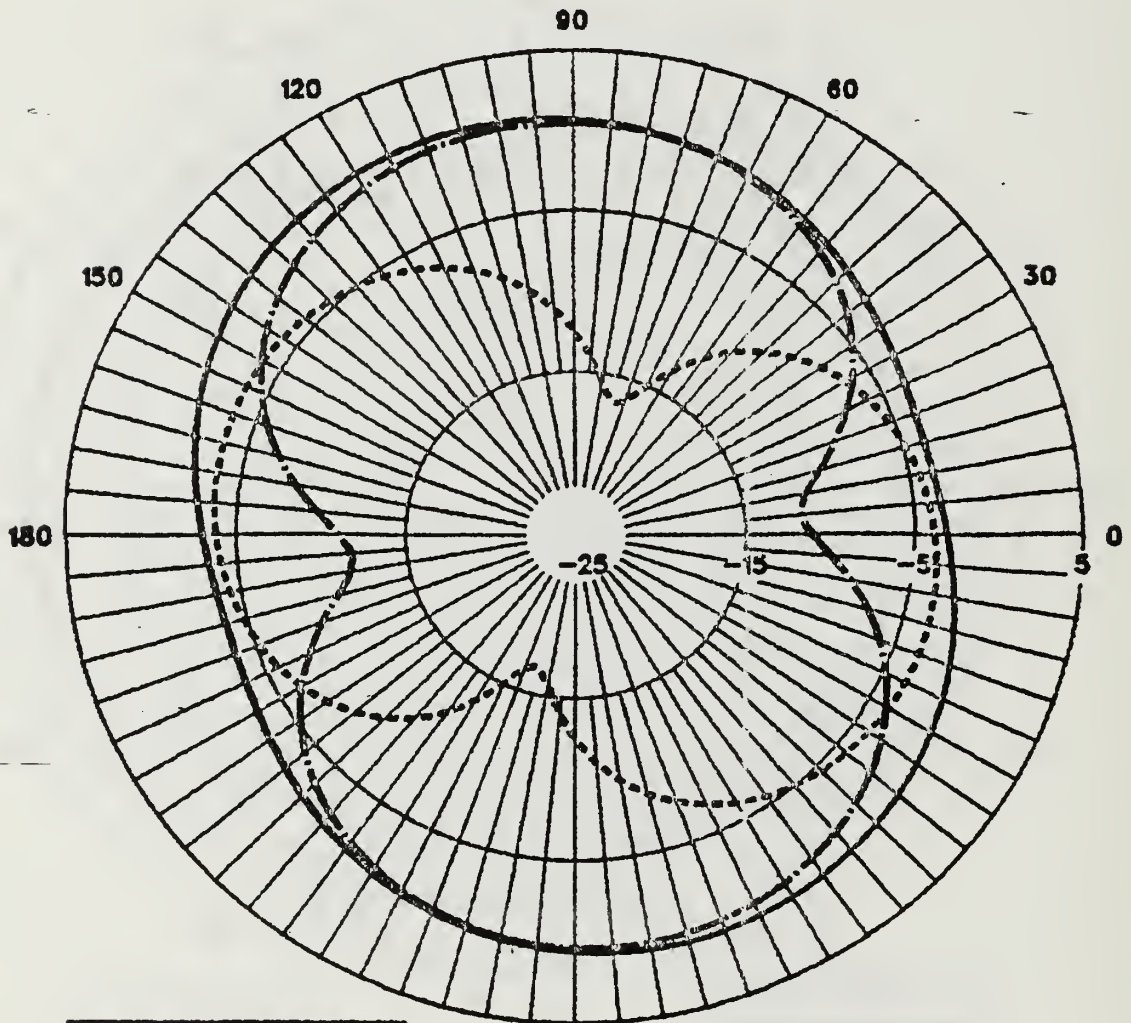
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LONG SHUNTED LOOP, FREE SPACE, HORIZ CUT, THETA=26



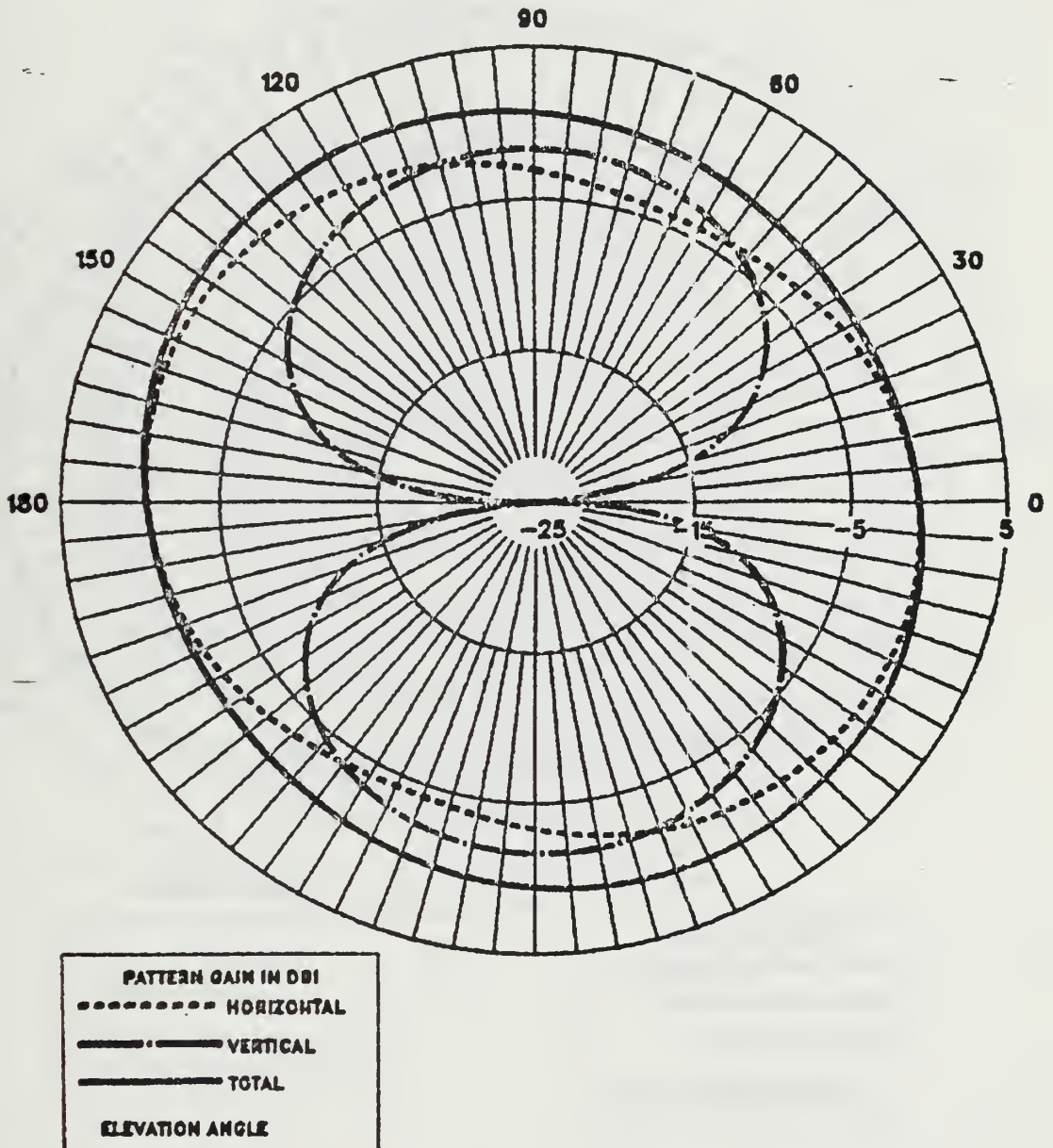
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LONG SHUNTED LOOP, FREE SPACE, VERT CUT, PHI=0



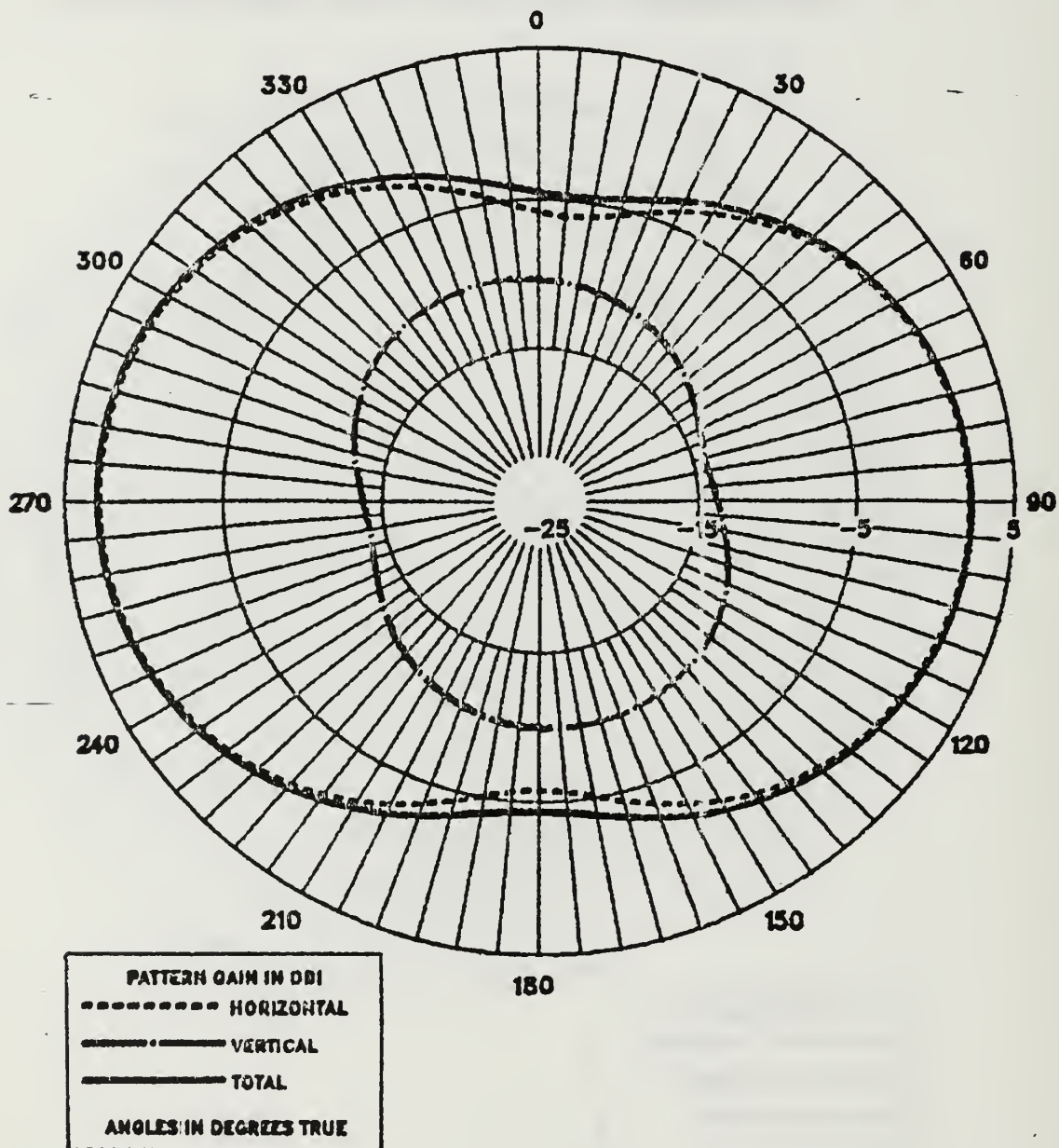
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LONG SHUNTED LOOP, FREE SPACE, VERT CUT, PHI=45



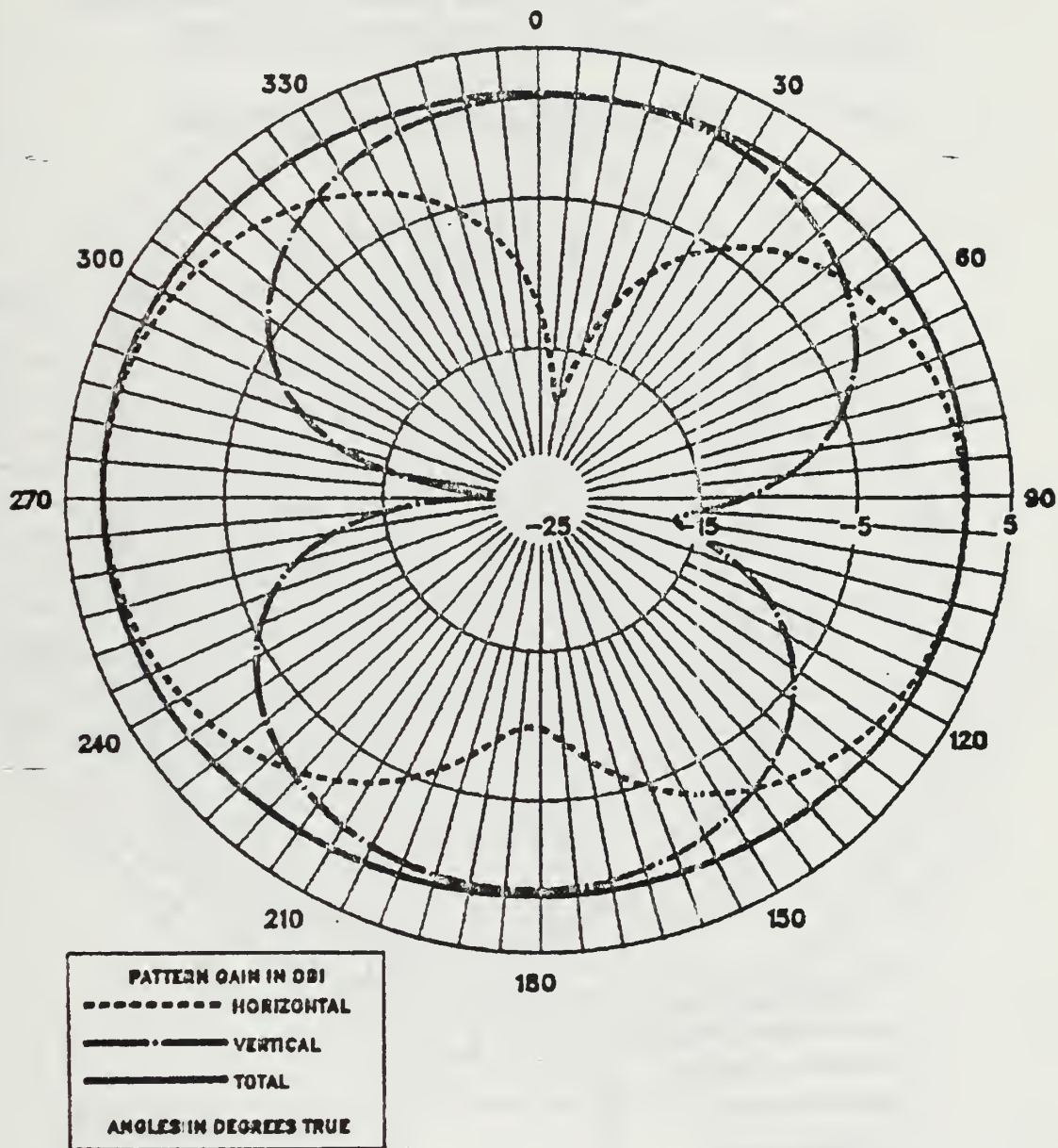
H65 IGUANA DATA RUN AT 5.696MHZ ON 8/20/87

LONG-WIRE ANT, FREE SPACE, HORIZ CUT, THETA=90



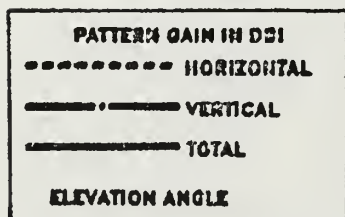
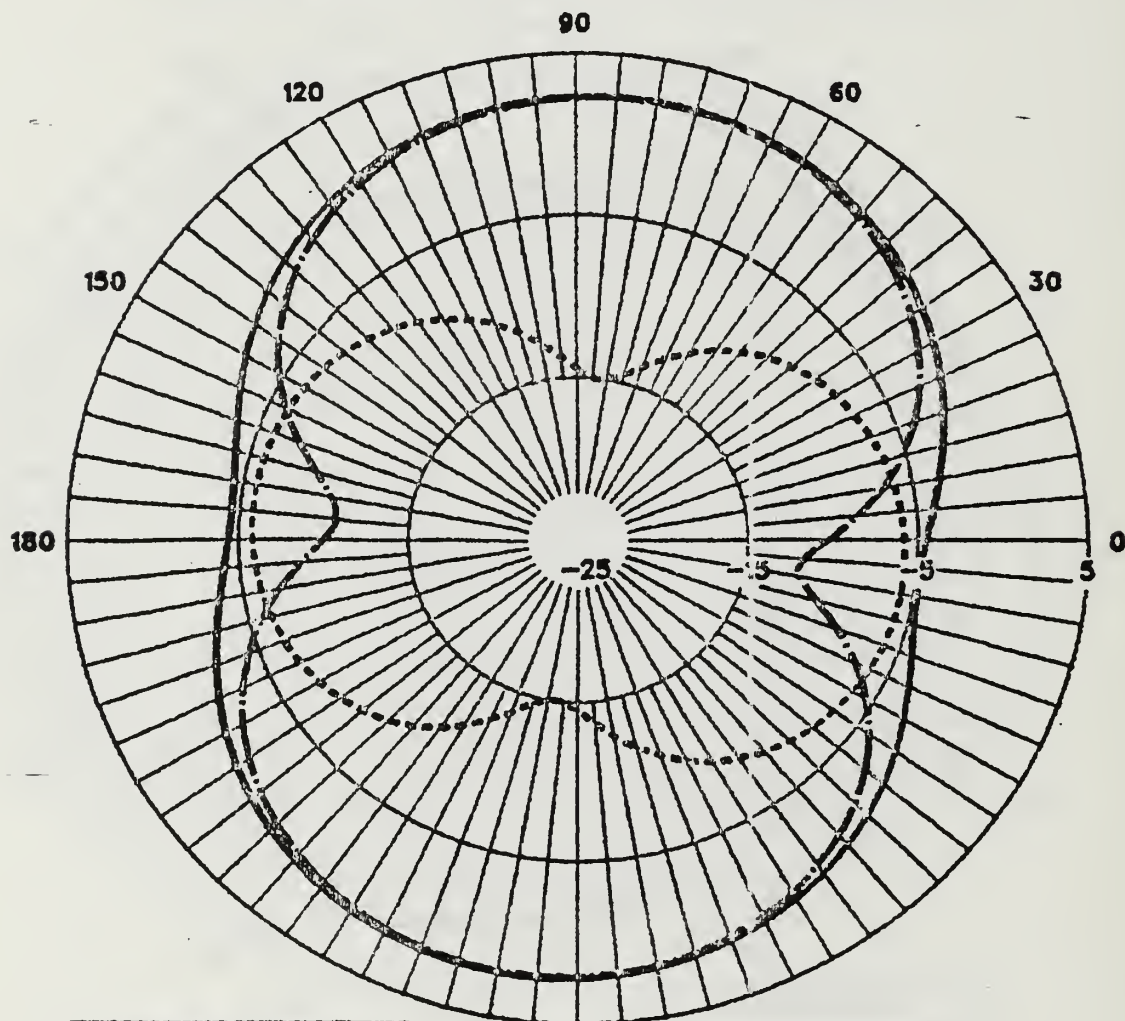
H65 IGUANA DATA RUN AT 5.696MHZ ON 8/20/87

LONG-WIRE ANT, FREE SPACE, HORIZ CUT, THETA=26



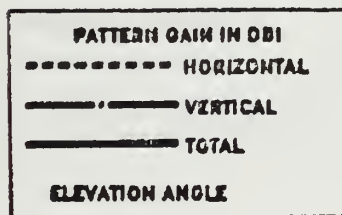
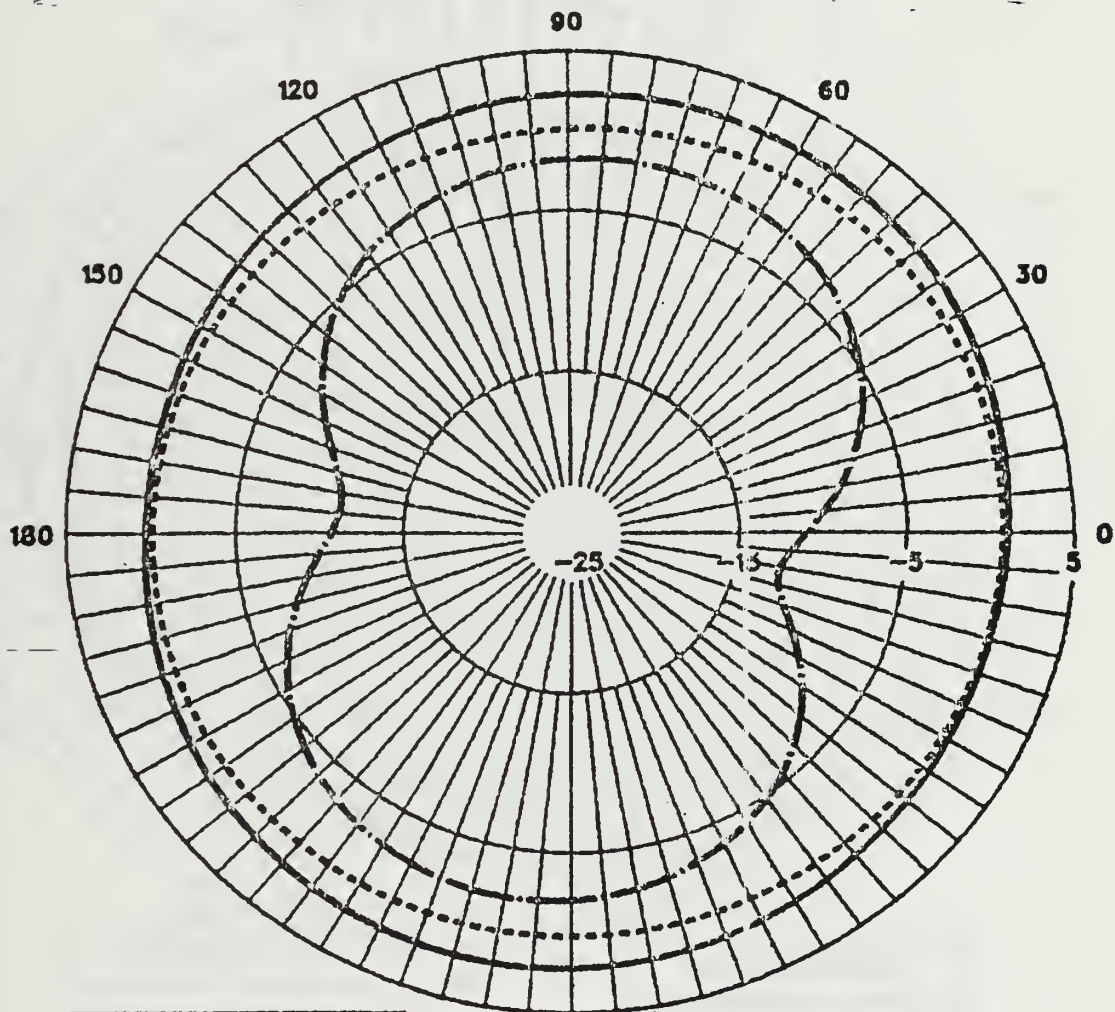
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LONG-WIRE ANT, FREE SPACE, VERT CUT, $\Phi=0$



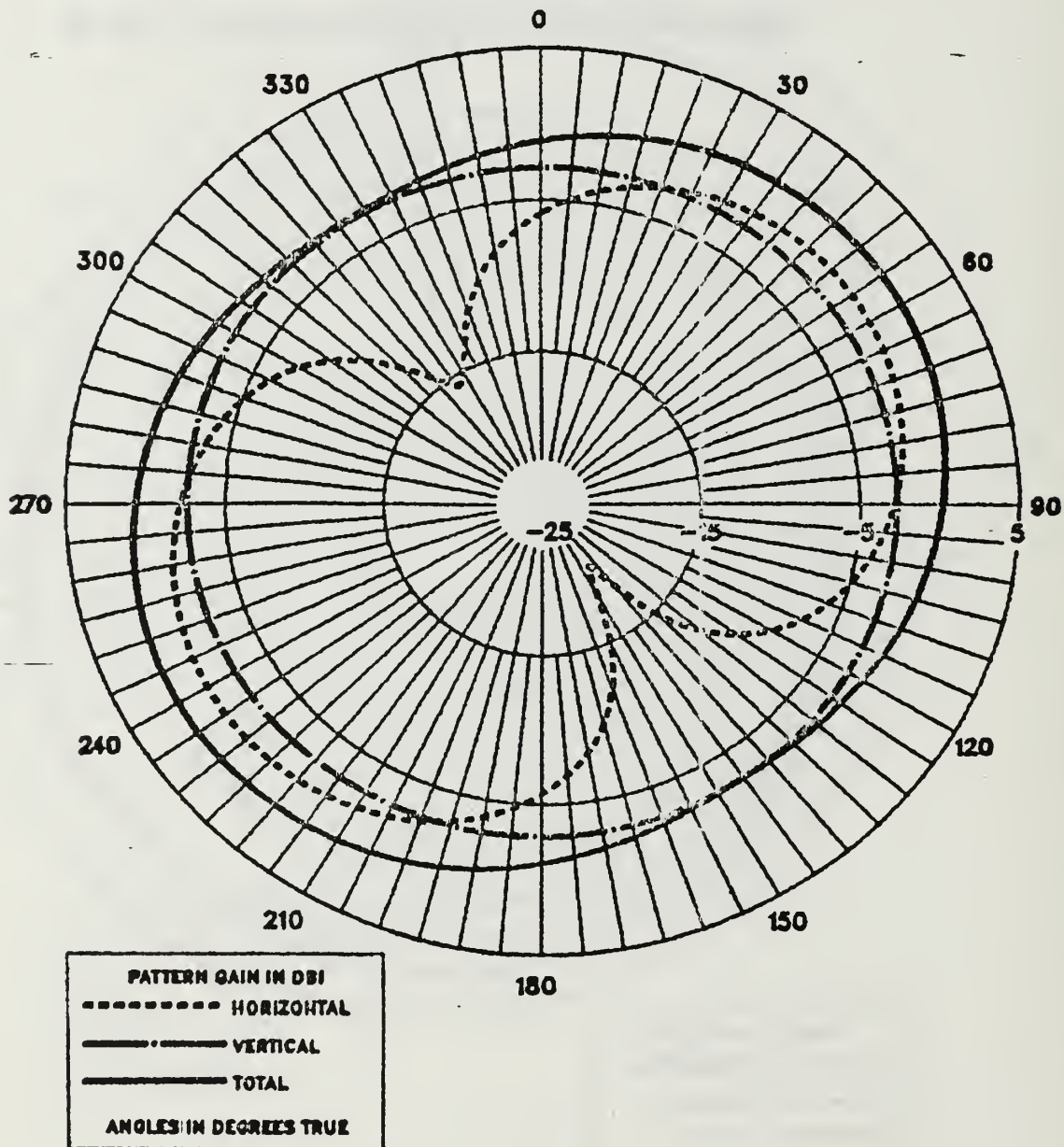
H65 IGUANA DATA RUN AT 5.696MHZ. ON 8/20/87

LONG-WIRE ANT, FREE SPACE, VERT CUT, PHI=45



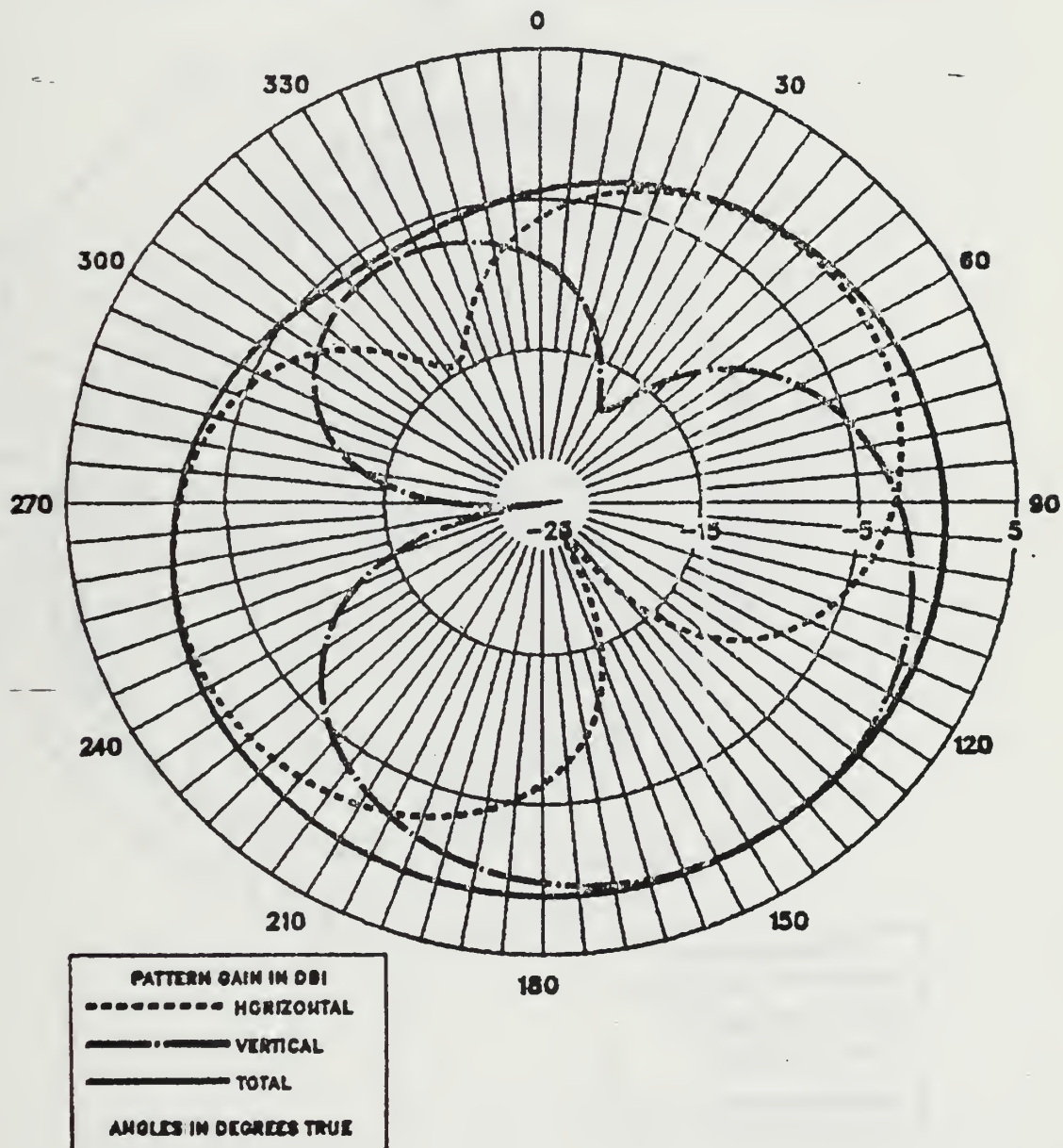
H65 IGUANA DATA RUN AT 5.696MHZ ON 8/20/87

COLLINS 437R-2, FREE SPACE, HORIZ CUT, THETA=90



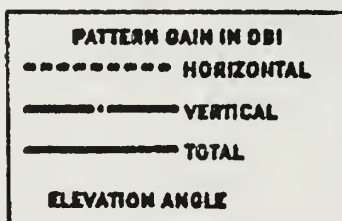
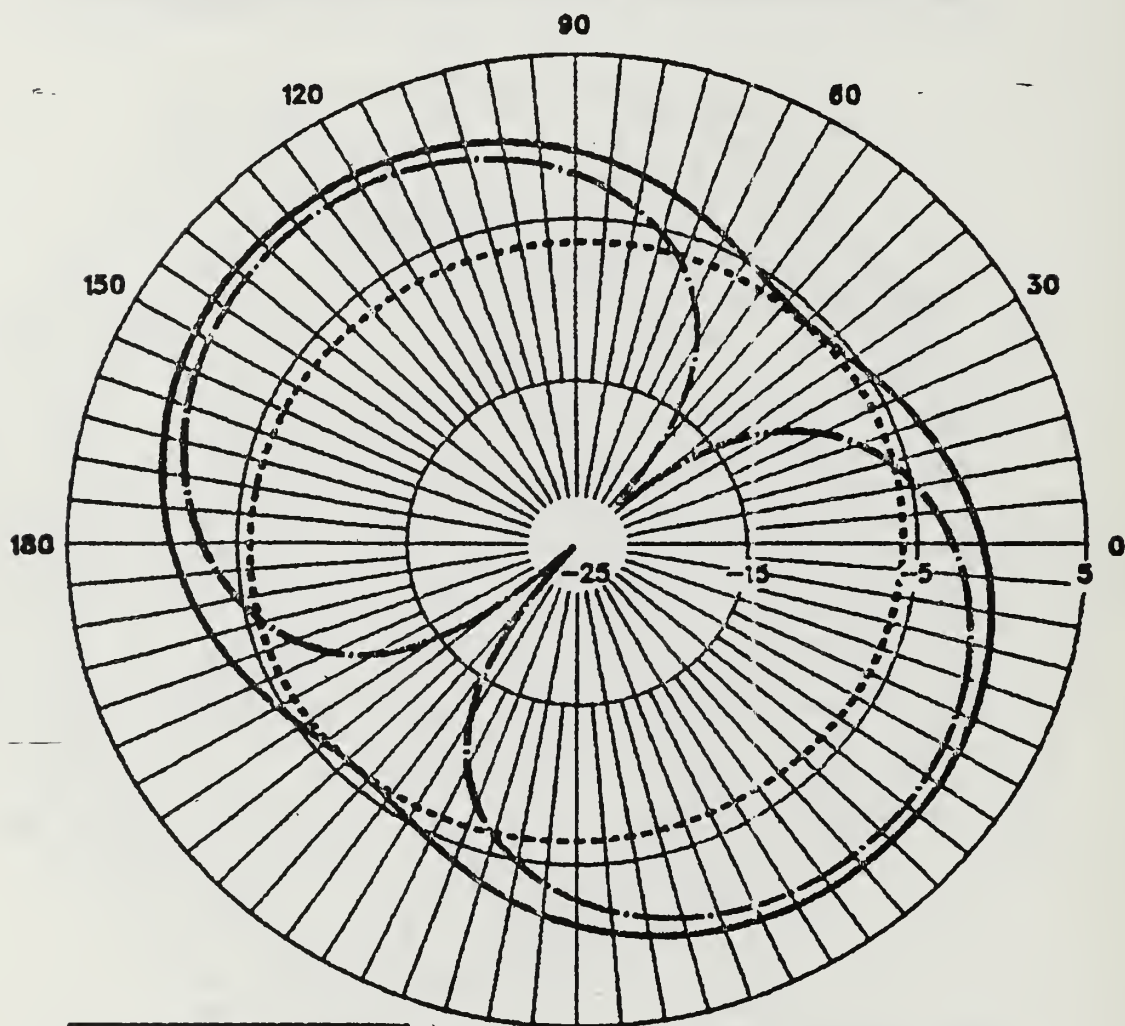
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COLLINS 437R-2, FREE SPACE, HORIZ CUT, THETA=26



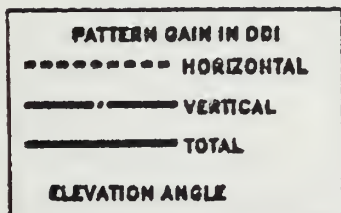
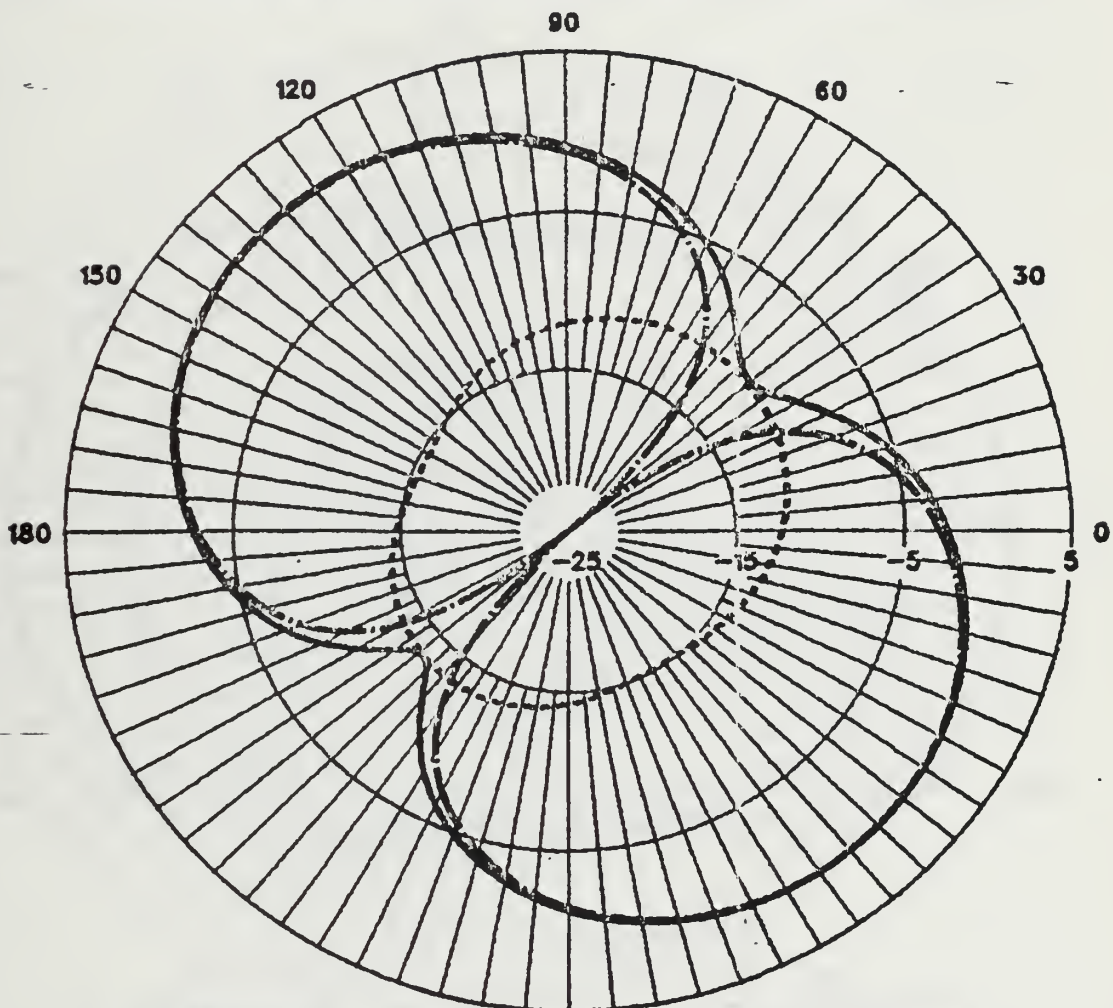
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COLLINS 437R-2, FREE SPACE, VERT CUT, PHI=0



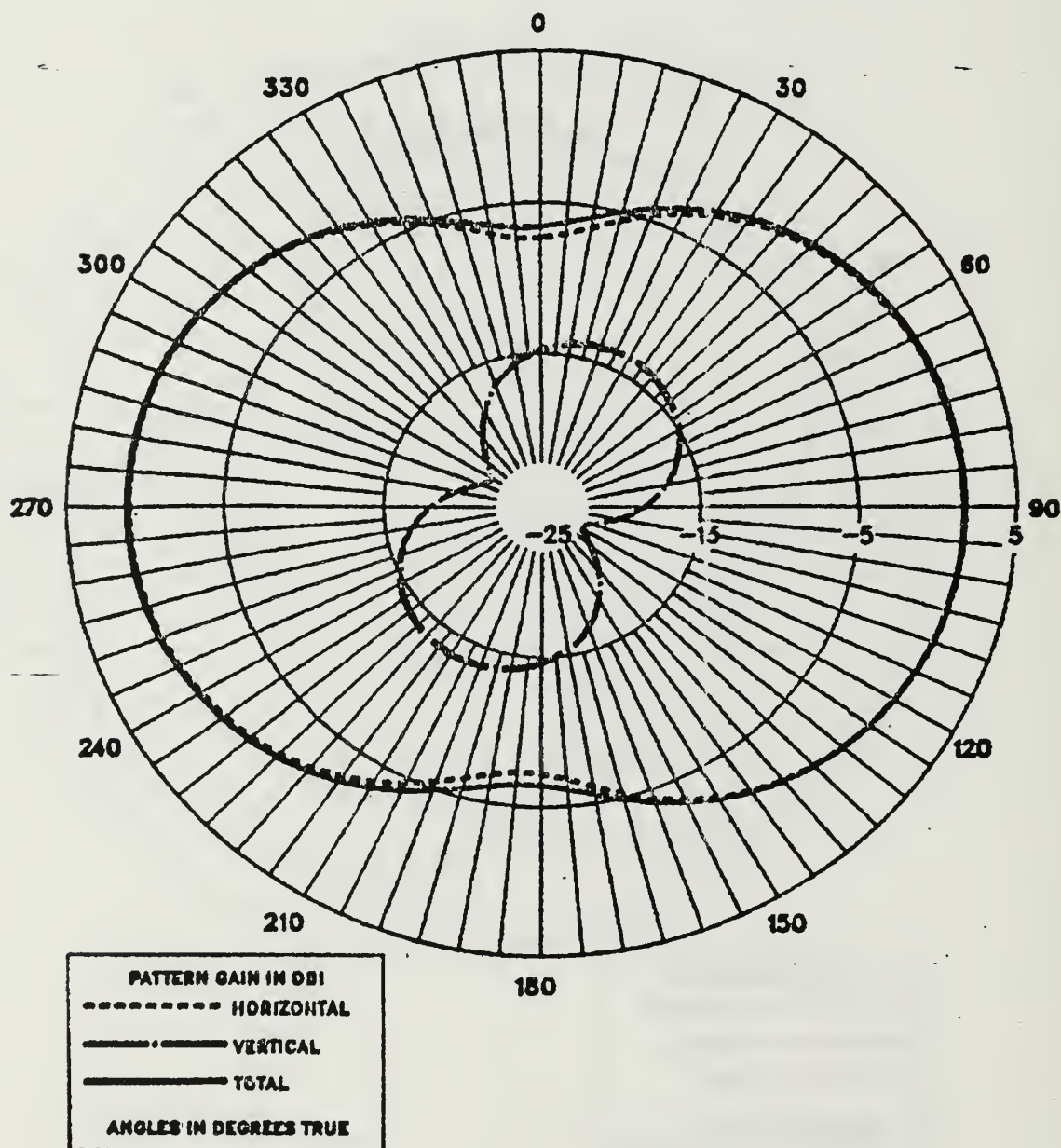
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COLLINS 437R-2, FREE SPACE, VERT CUT, PHI=45



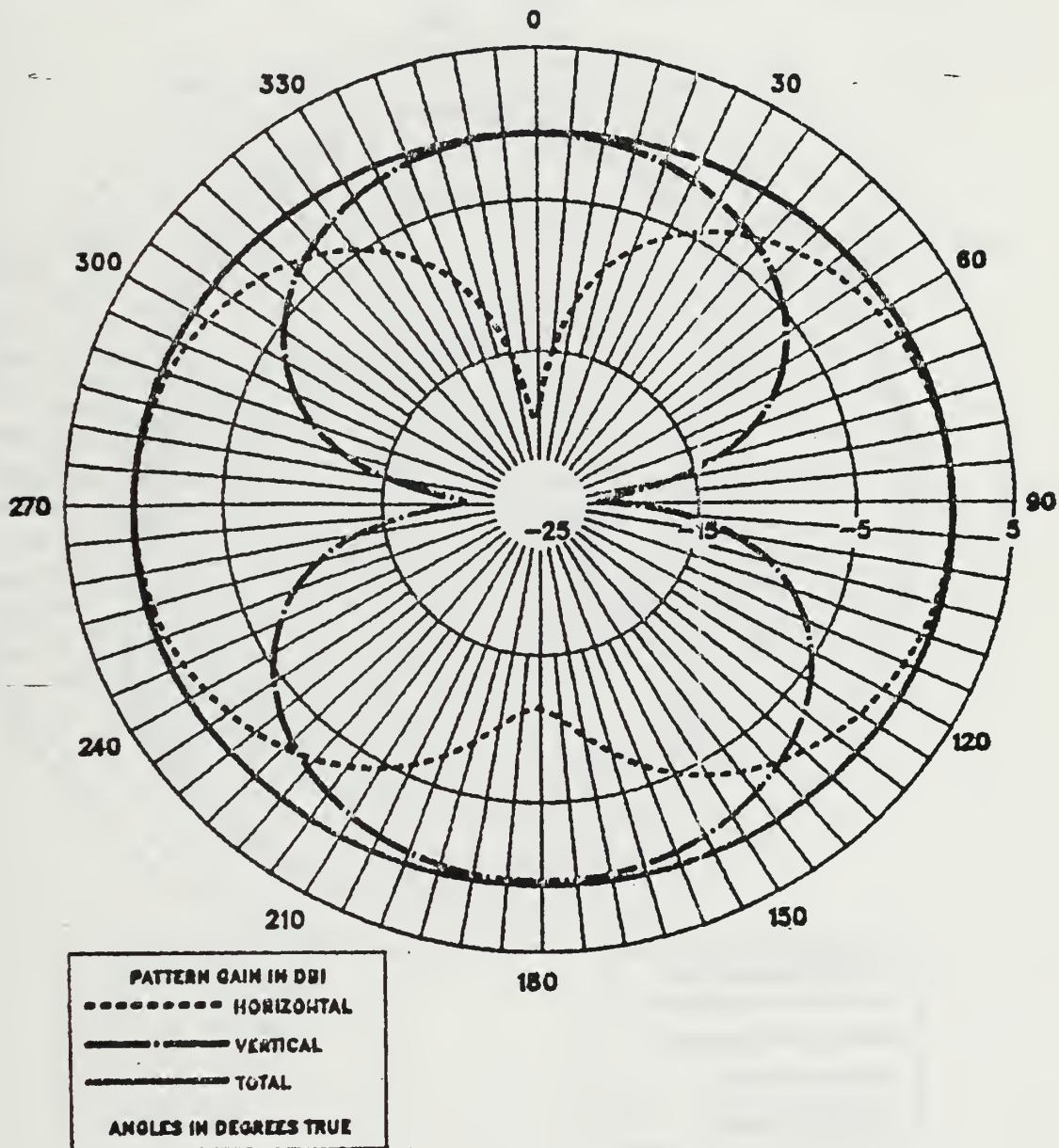
H65 IGUANA DATA RUN AT 5.696MHZ. ON 8/20/87

ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CUT, THETA=90



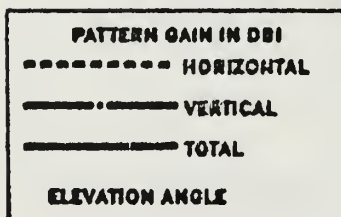
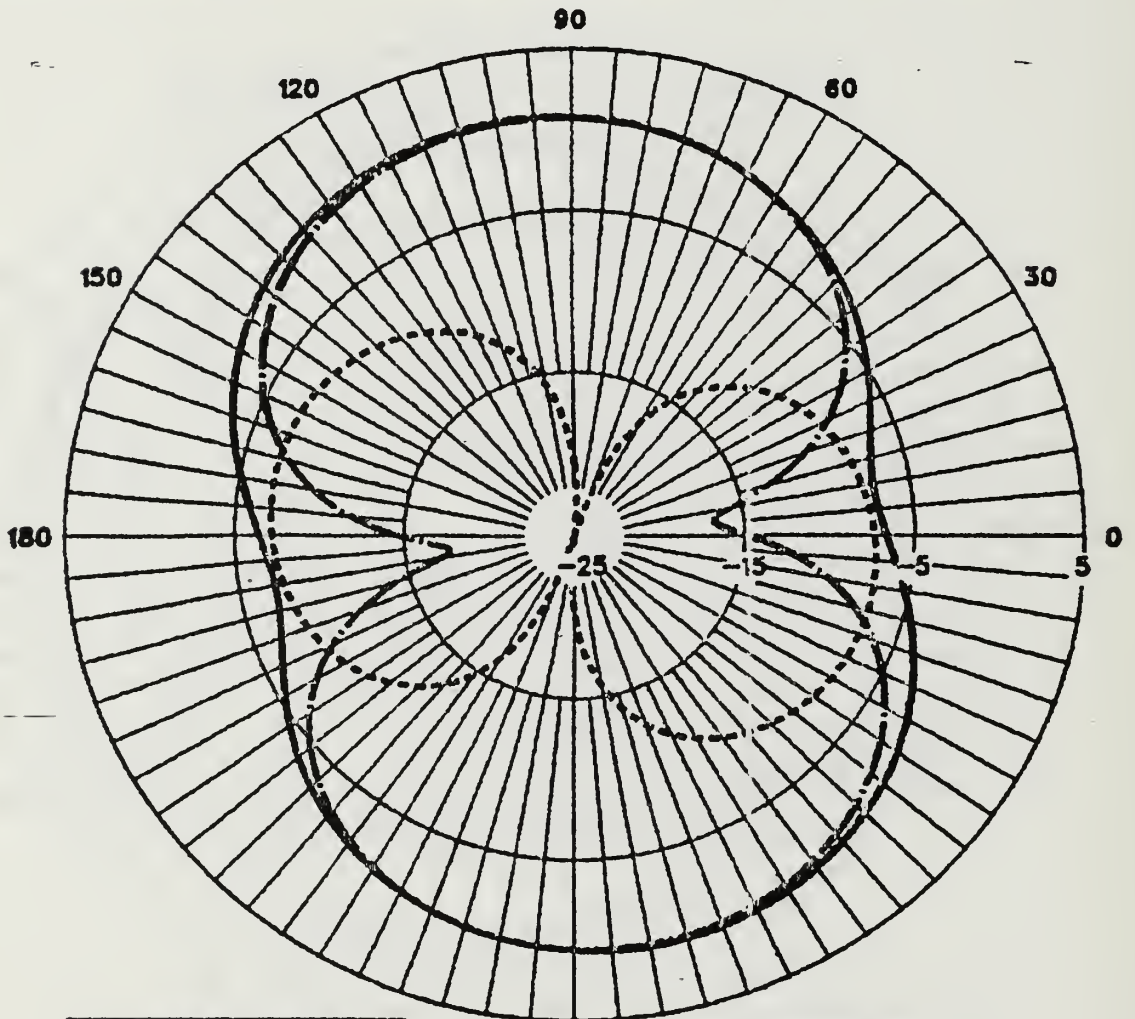
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ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CUT, THETA=26



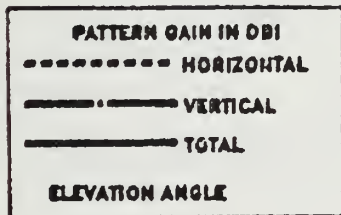
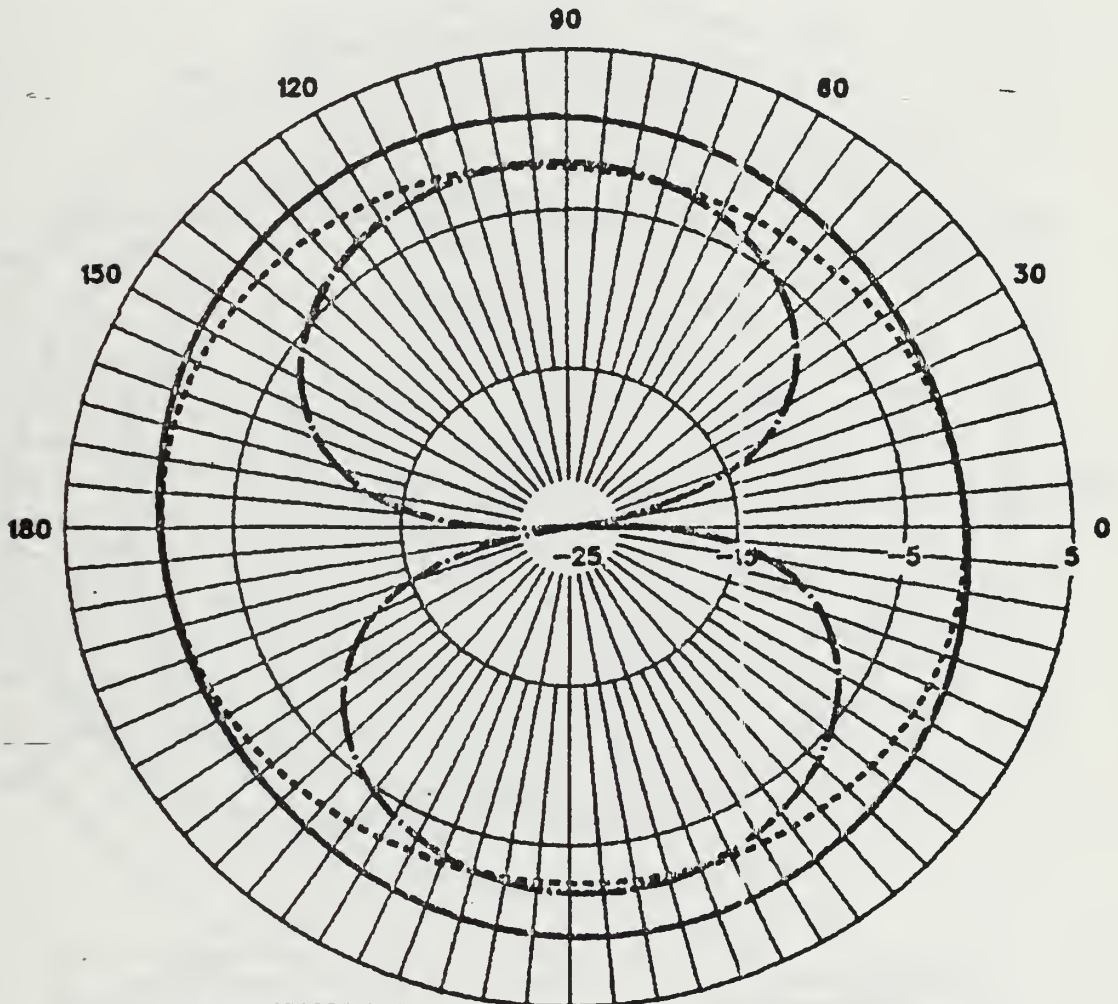
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ARMY-TYPE TUBE ANT, FREE SPACE, VERT CUT, PHI=0



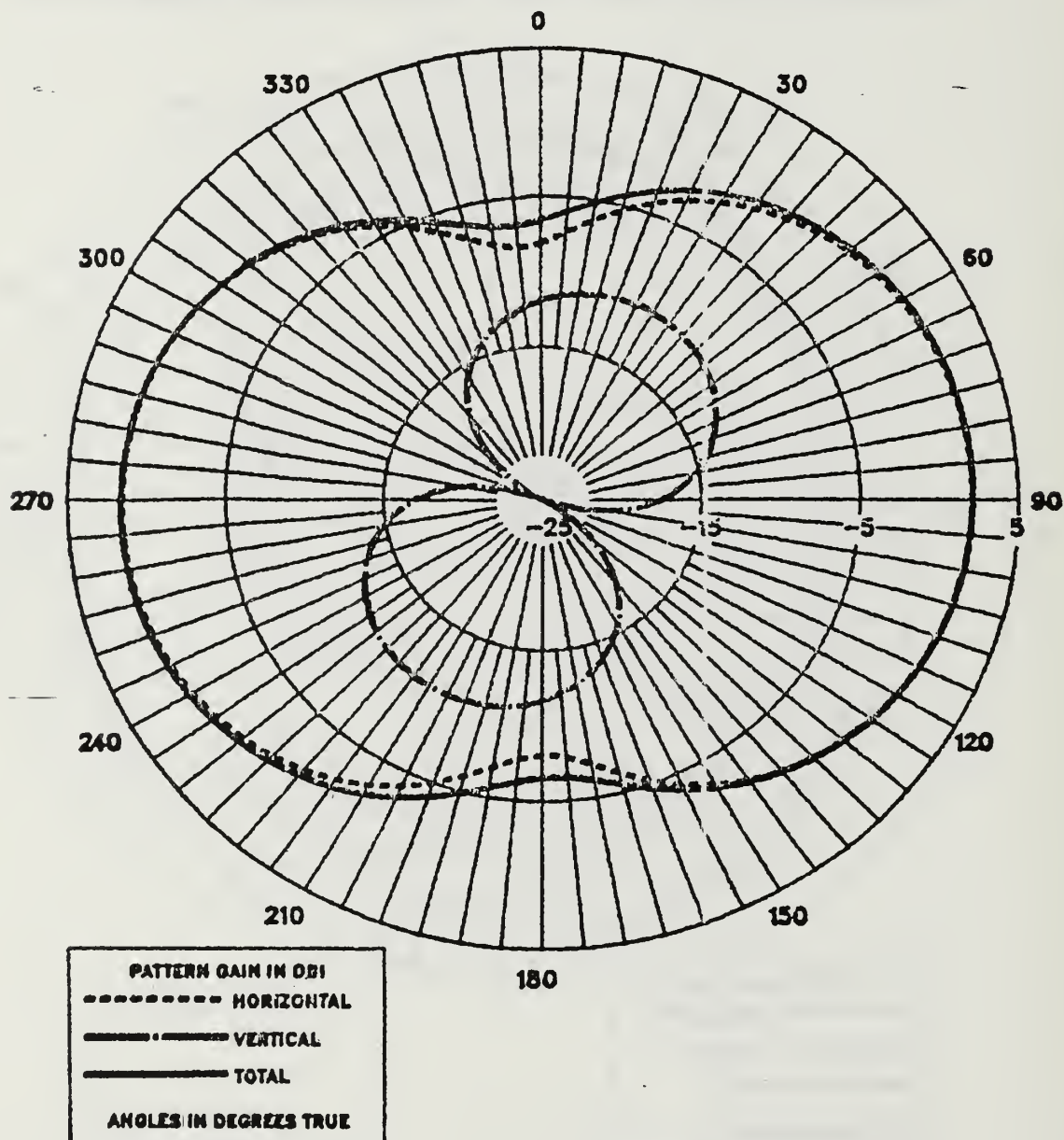
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ARMY-TYPE TUBE ANT, FREE SPACE, VERT CUT, PHI=45



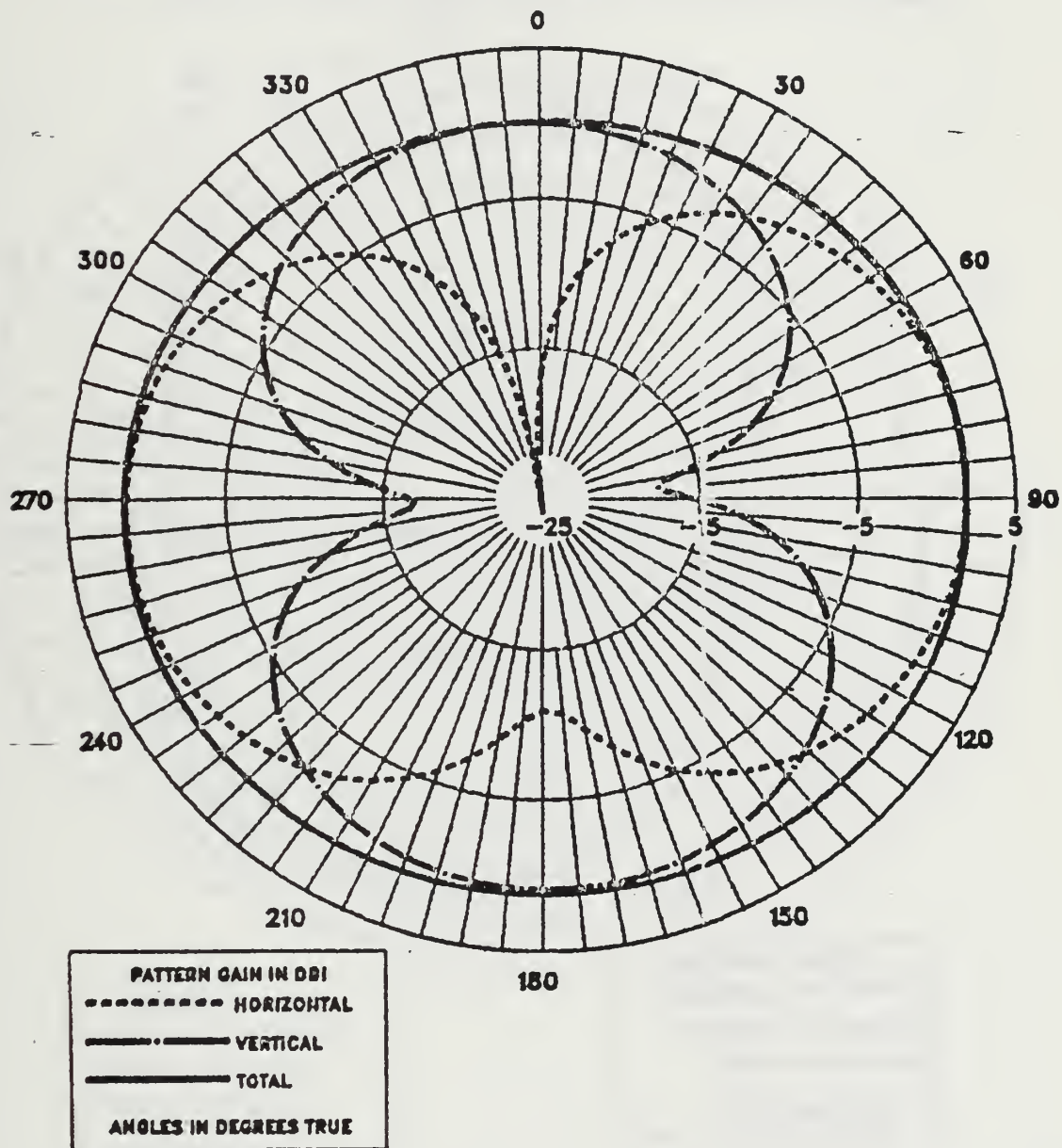
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LONG SHUNTED LOOP, FREE SPACE, HORIZ CUT, THETA=90



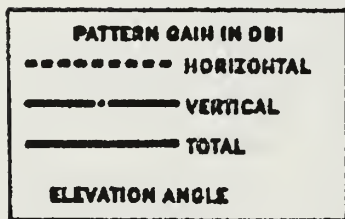
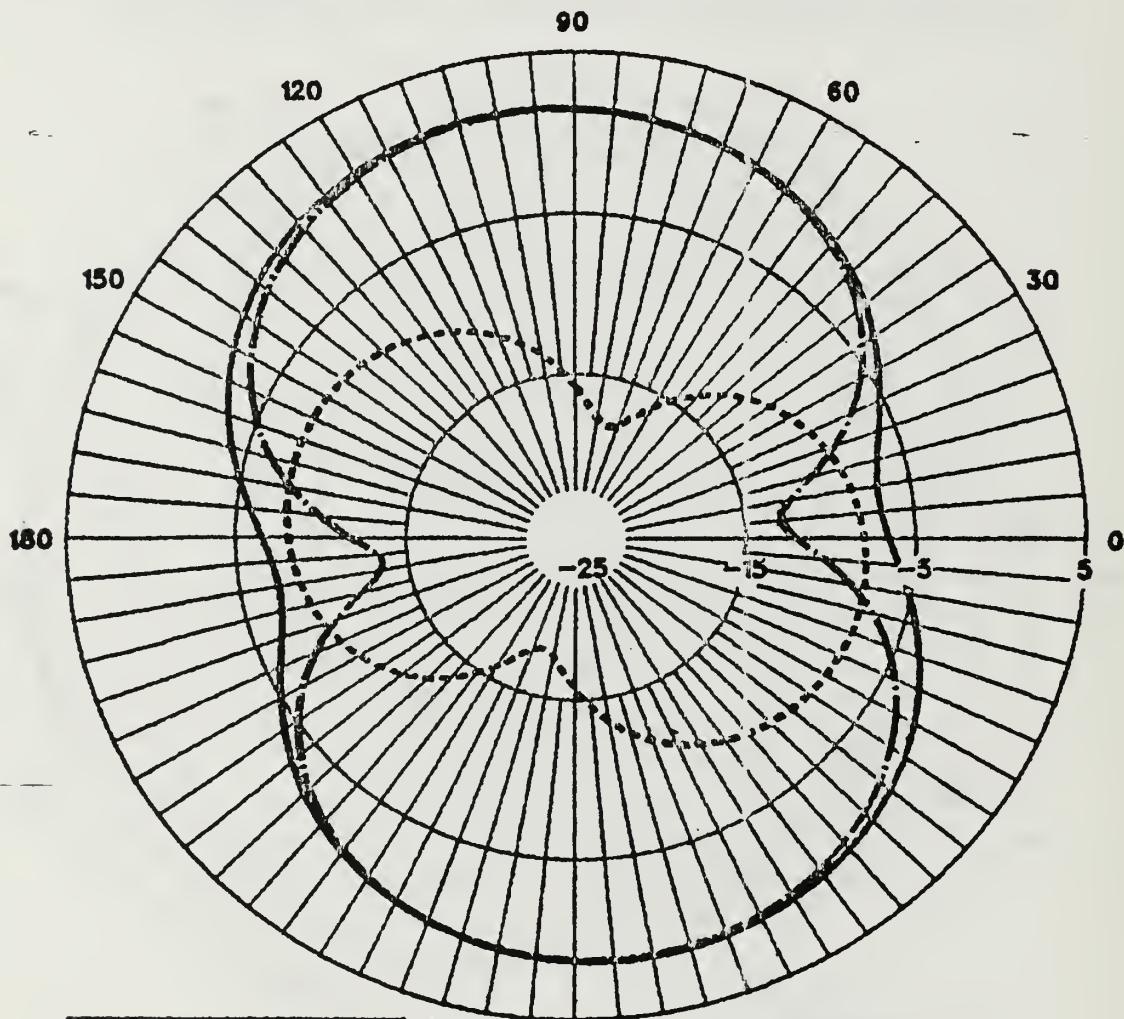
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LONG SHUNTED LOOP, FREE SPACE, HORIZ CUT, THETA=26



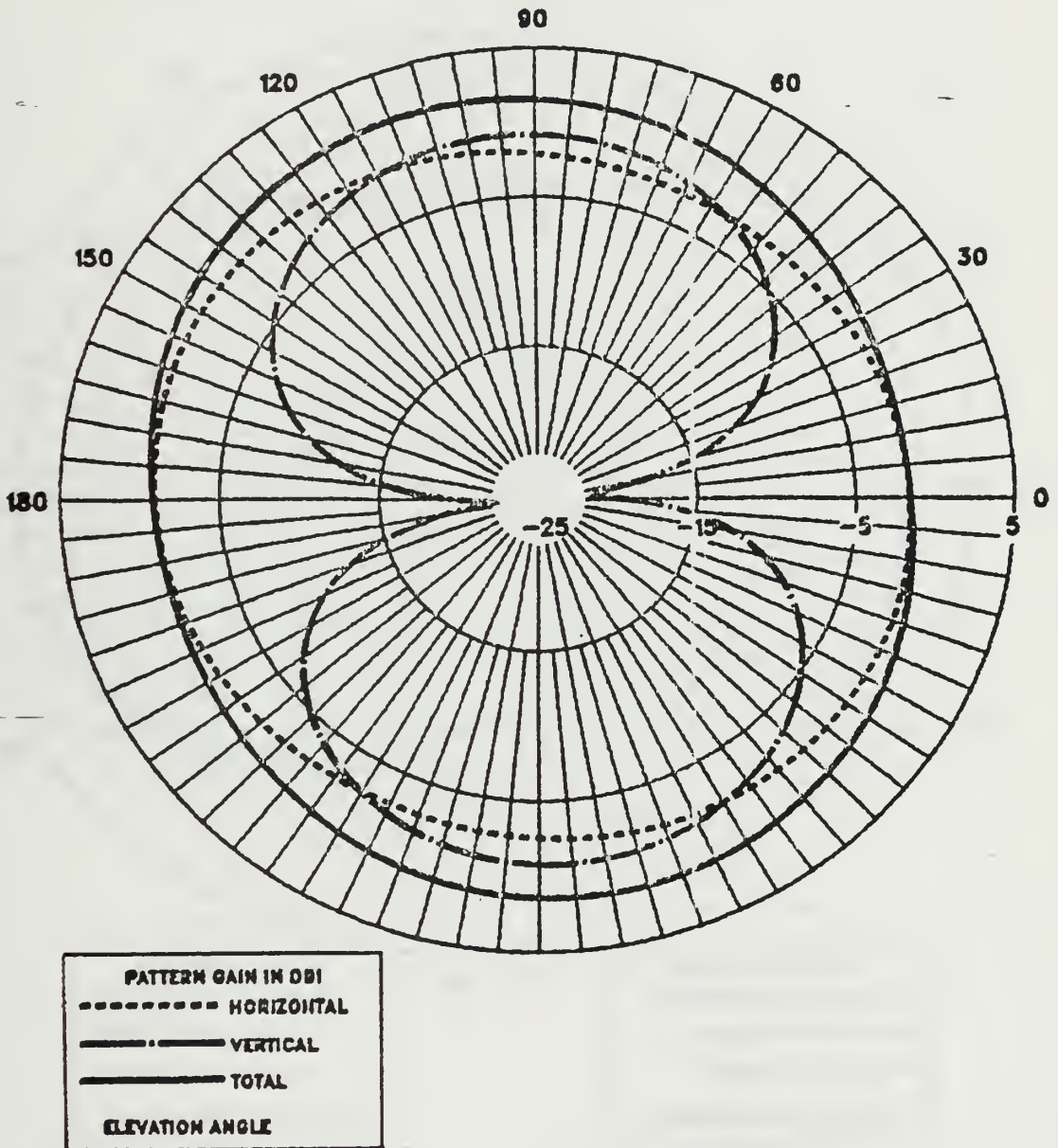
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LONG SHUNTED LOOP, FREE SPACE, VERT CUT, PHI=0



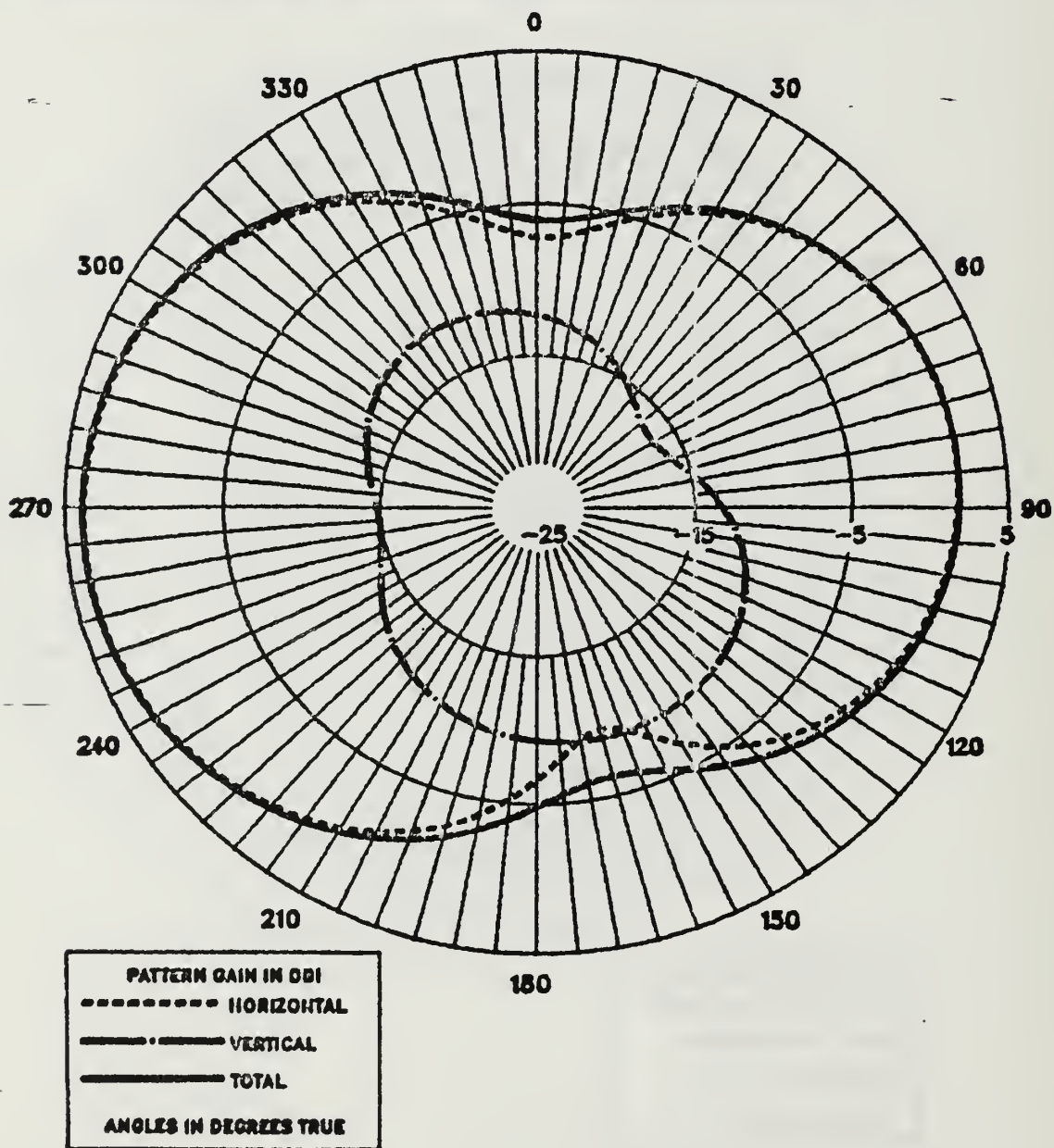
H65 IGUANA DATA RUN AT 5.696MHZ ON 8/20/87

LONG SHUNTED LOOP, FREE SPACE, VERT CUT, $\Phi=45$



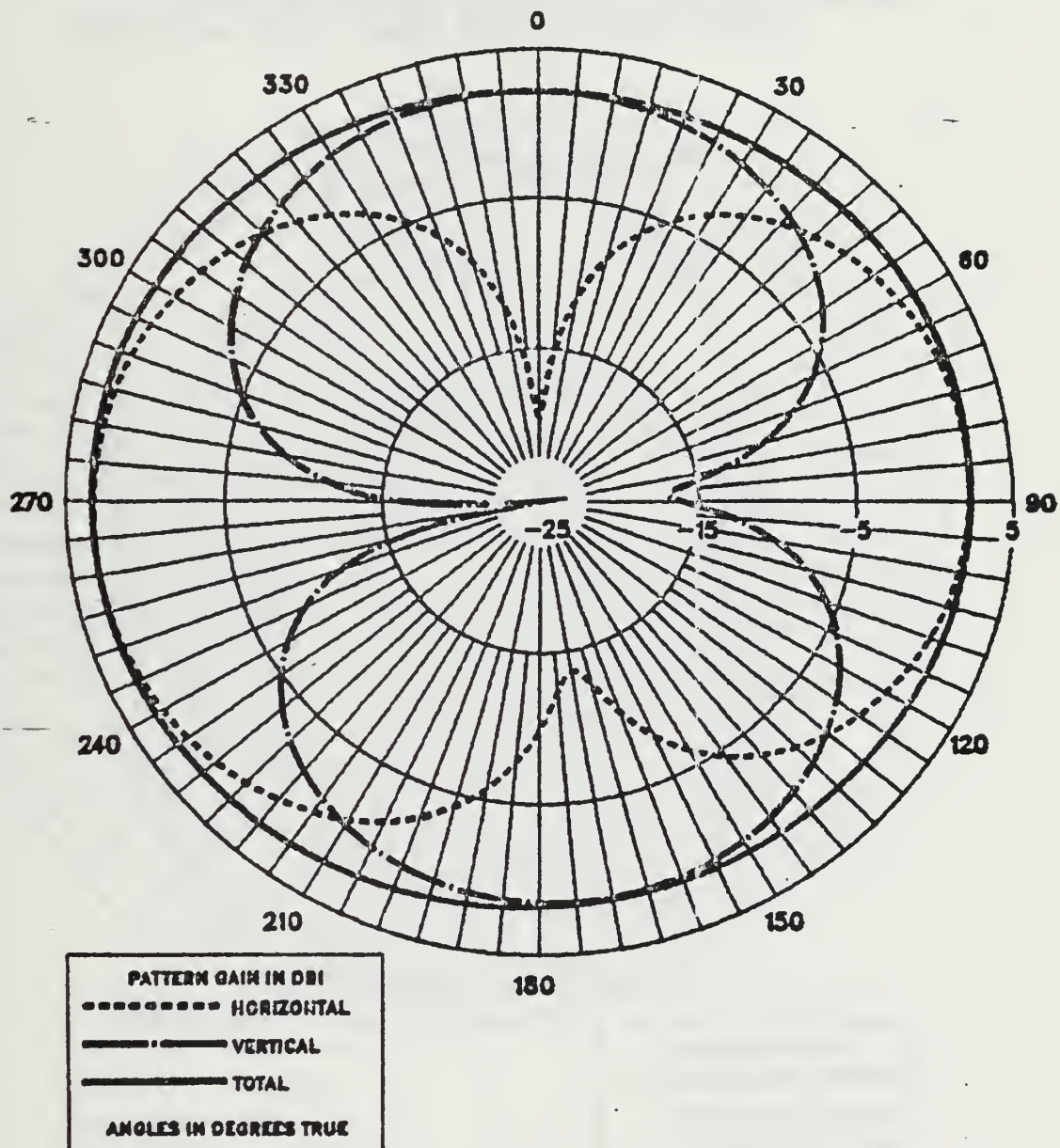
H65 IGUANA DATA RUN AT 7.645MHZ ON 8/22/87

LONG-WIRE ANT, FREE SPACE, HORIZ CUT, THETA=90



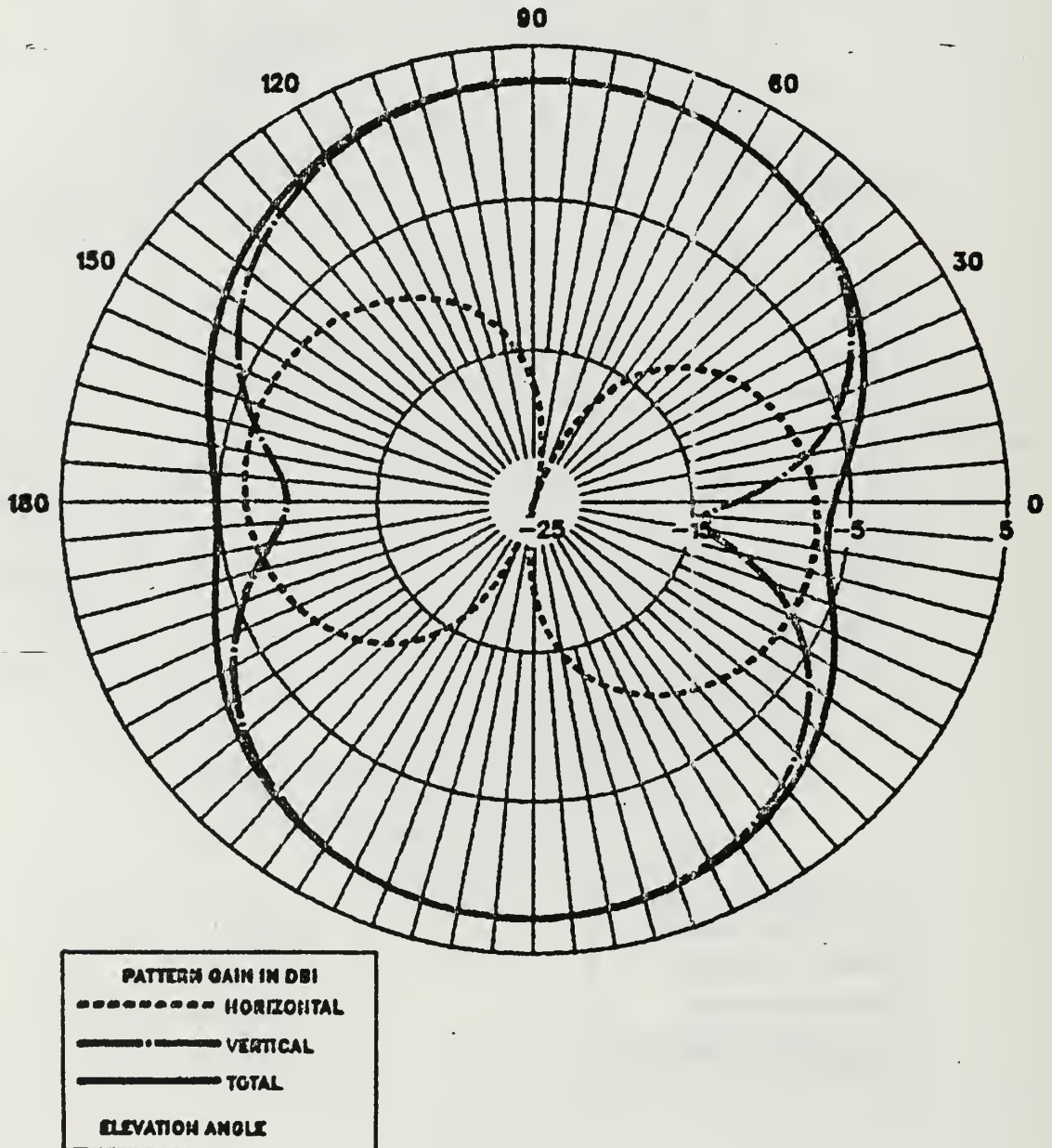
H65 IGUANA DATA RUN AT 7.645MHZ ON 8/22/87

LONG-WIRE ANT, FREE SPACE, HORIZ CUT, THETA=26



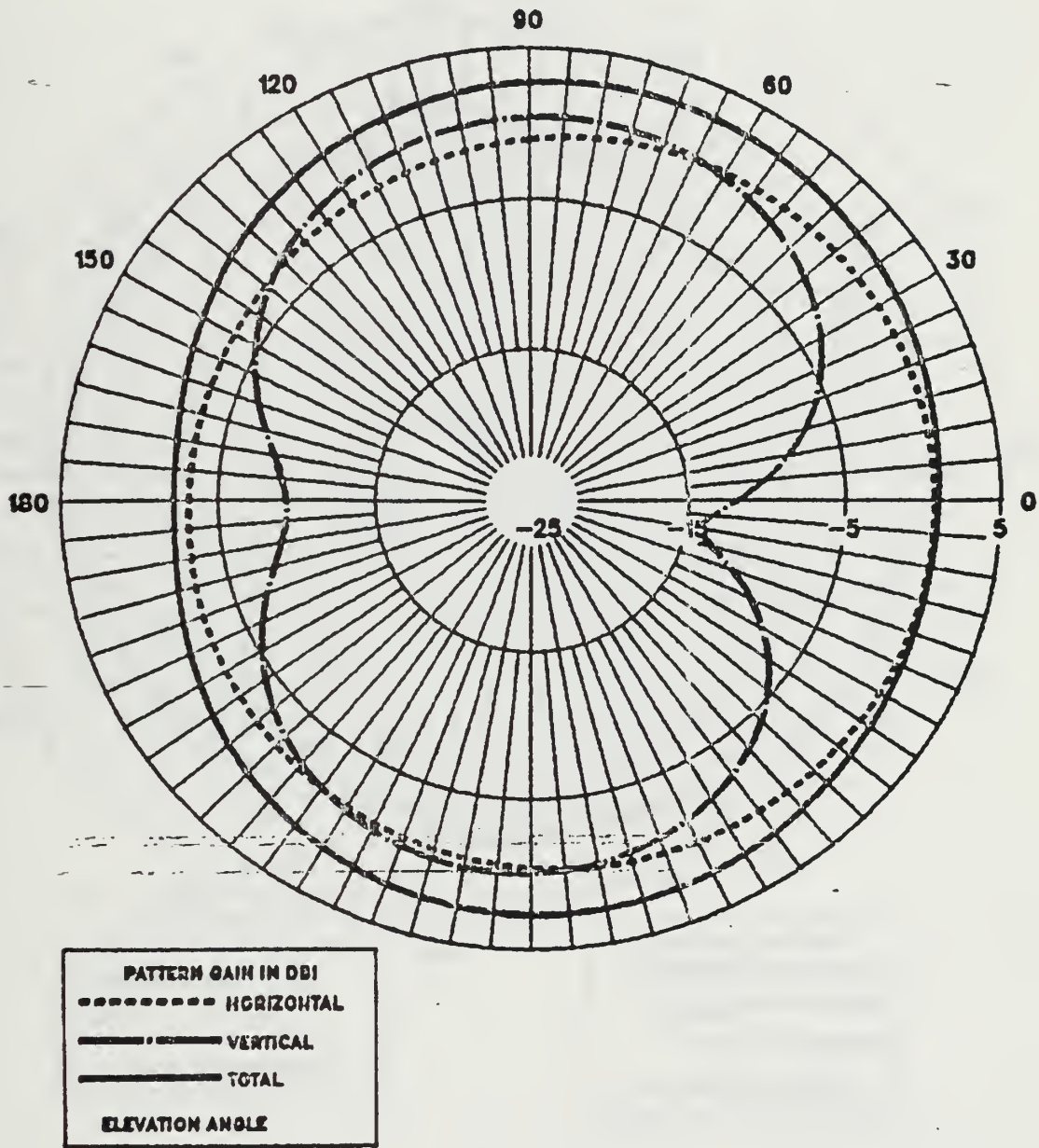
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LONG-WIRE ANT, FREE SPACE, VERT CUT, PHI=0



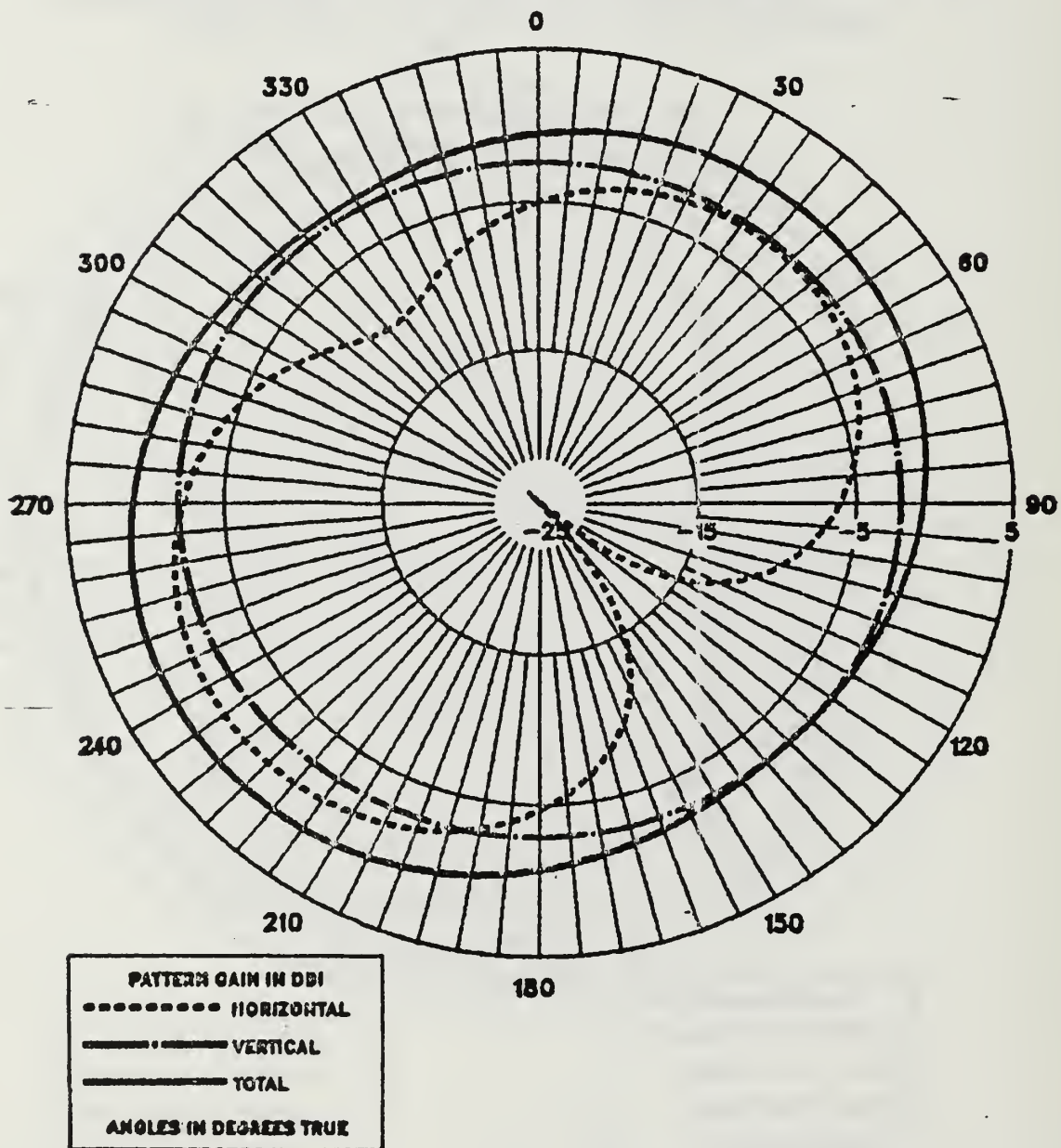
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LONG-WIRE ANT, FREE SPACE, VERT CUT, PHI=45



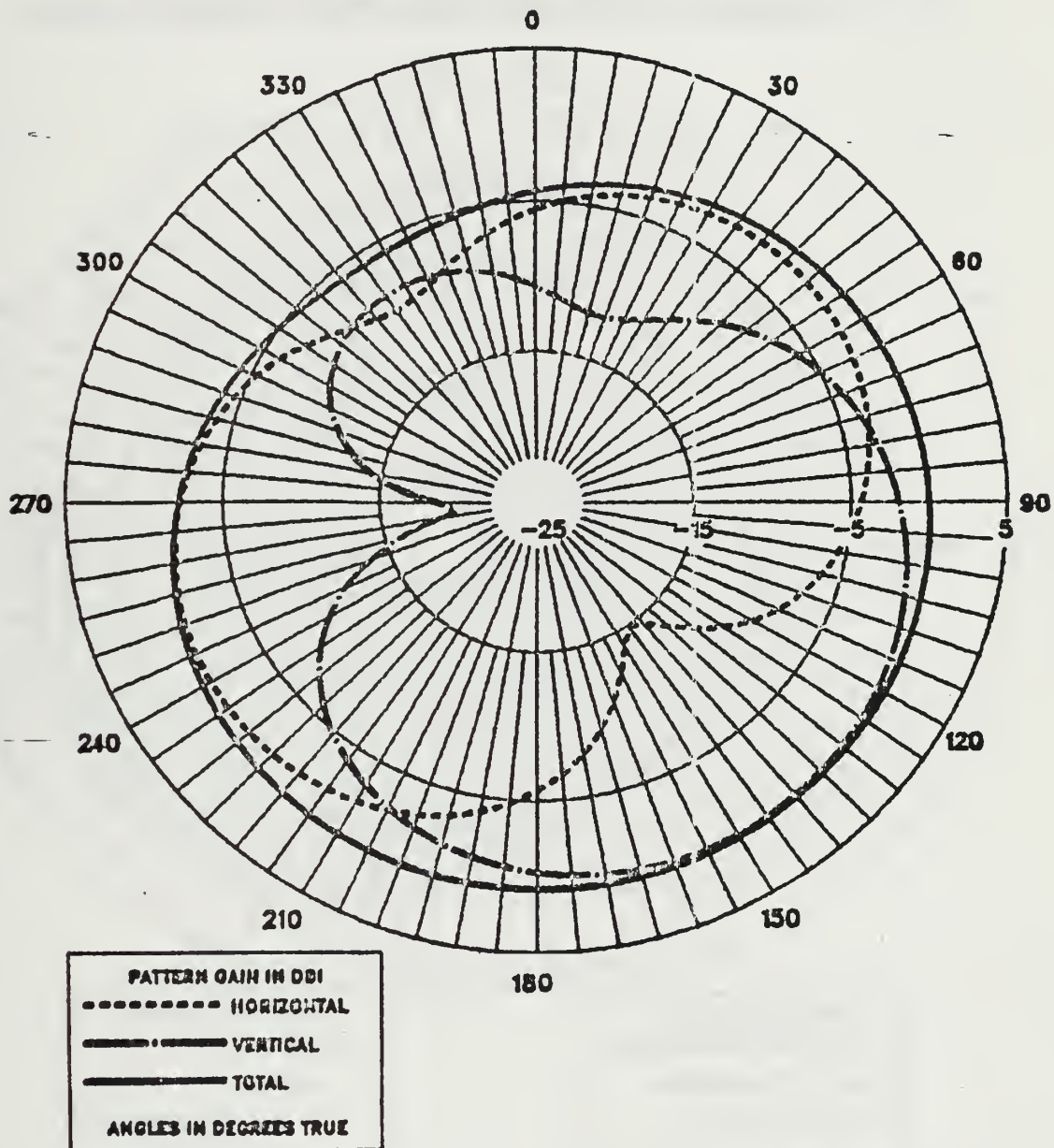
H65 IGUANA DATA RUN AT 7.645MHZ ON 8/22/87

COLLINS 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=90



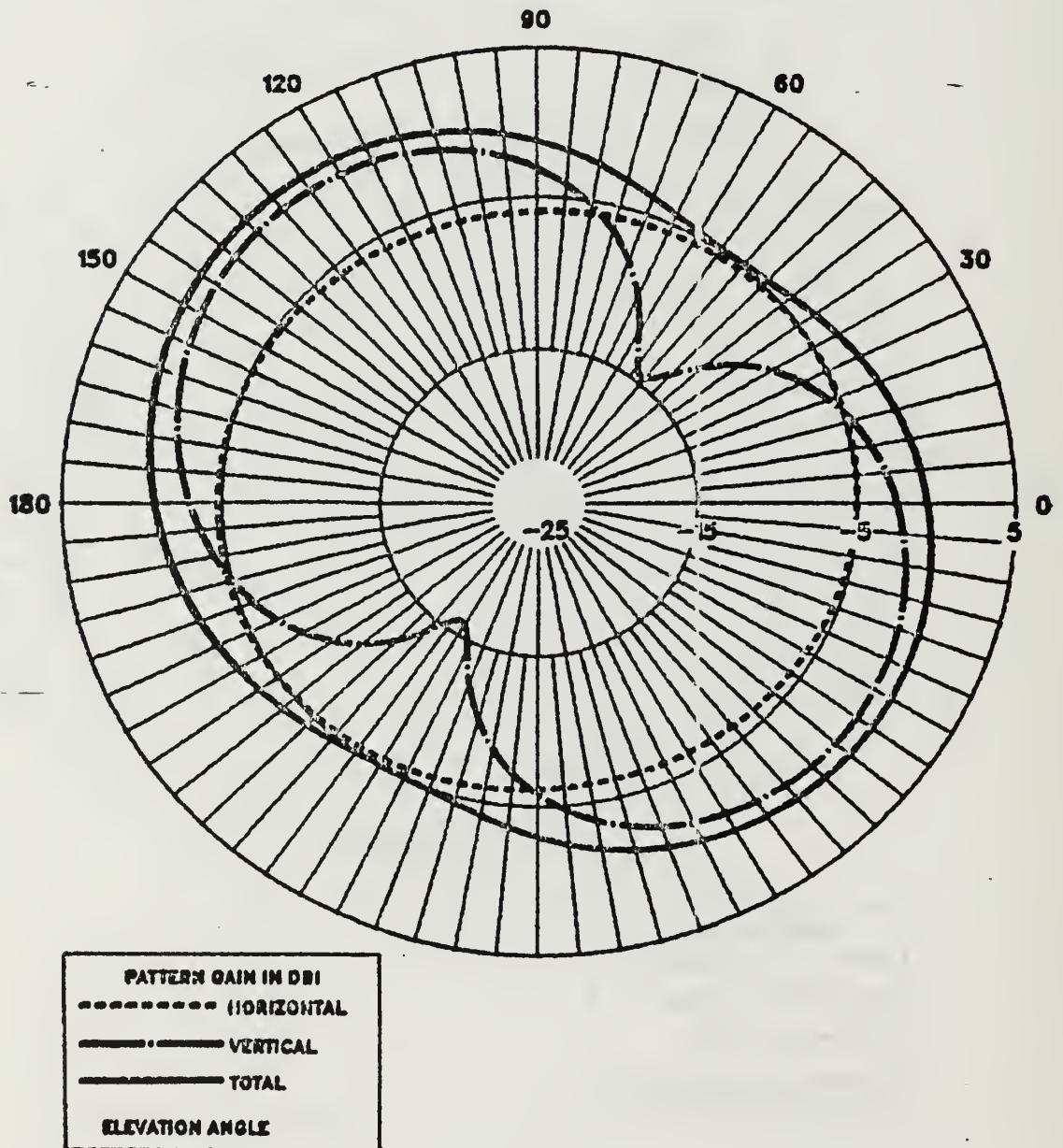
H65 IGUANA DATA RUN AT 7.645MHZ ON 8/22/87

COLLINS 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=26



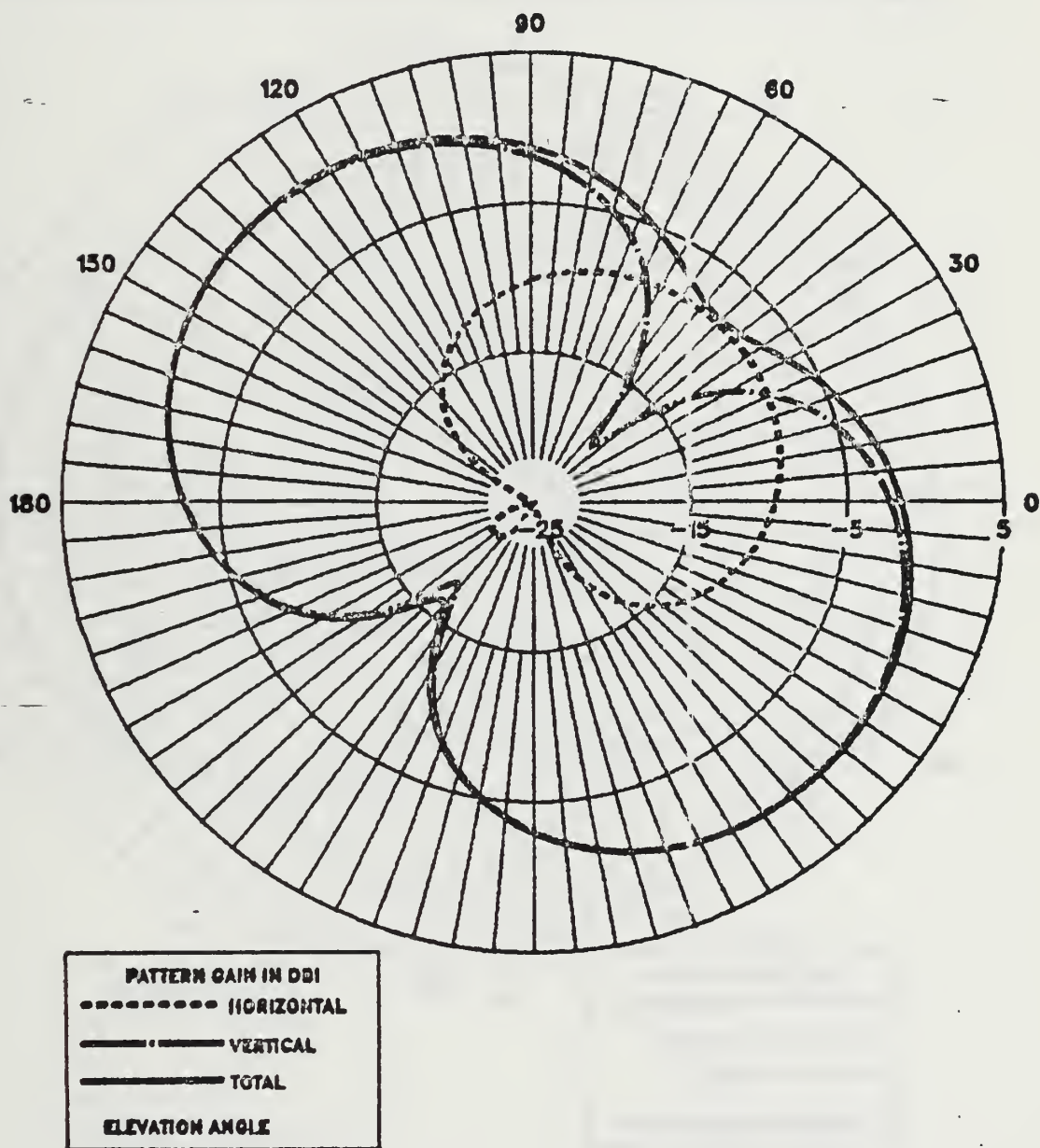
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COLLINS 437R-2 ANT, FREE SPACE, VERT CUT, PHI=0



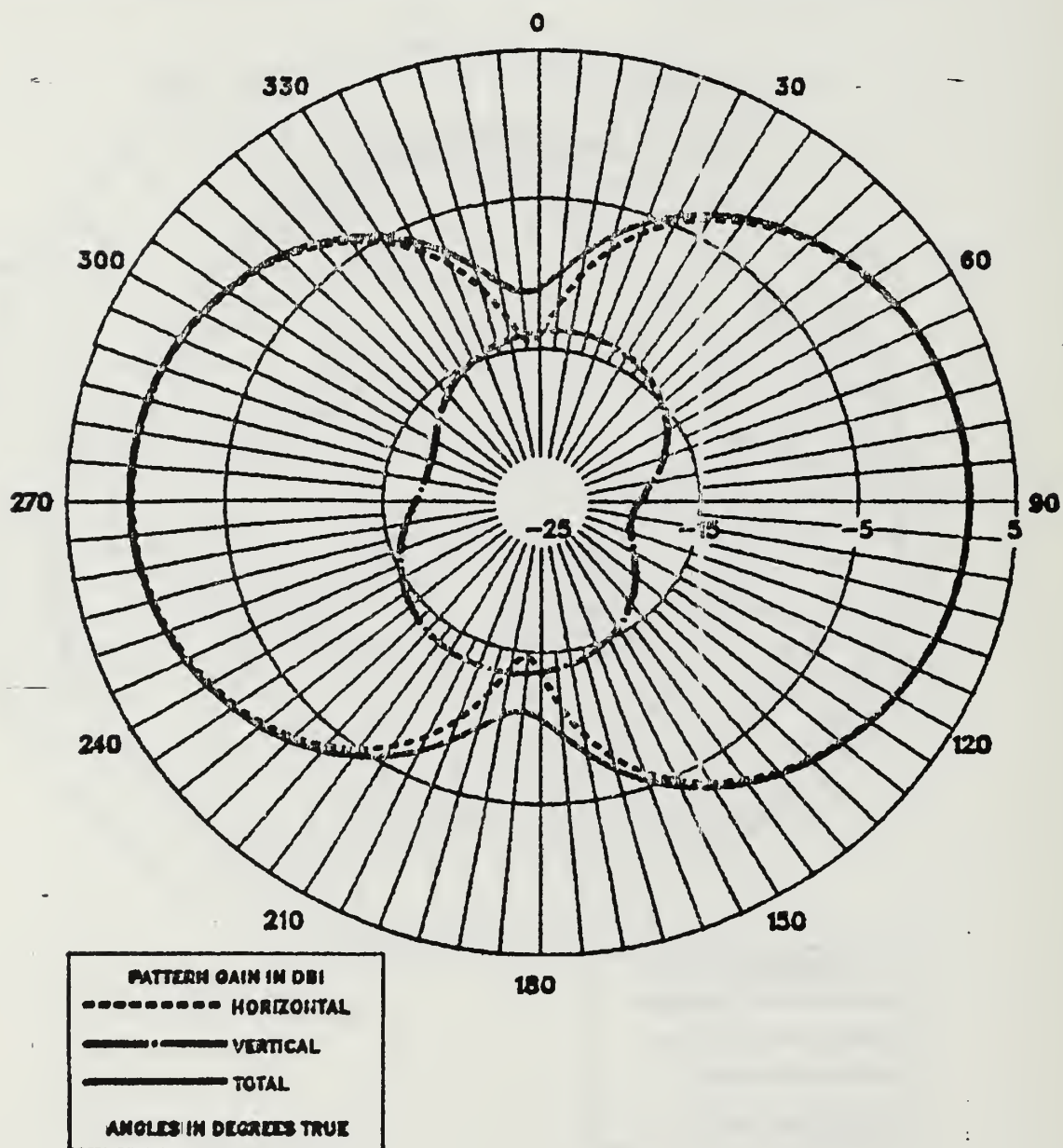
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COLLINS 437R-2 ANT, FREE SPACE, VERT CUT, PHI=45



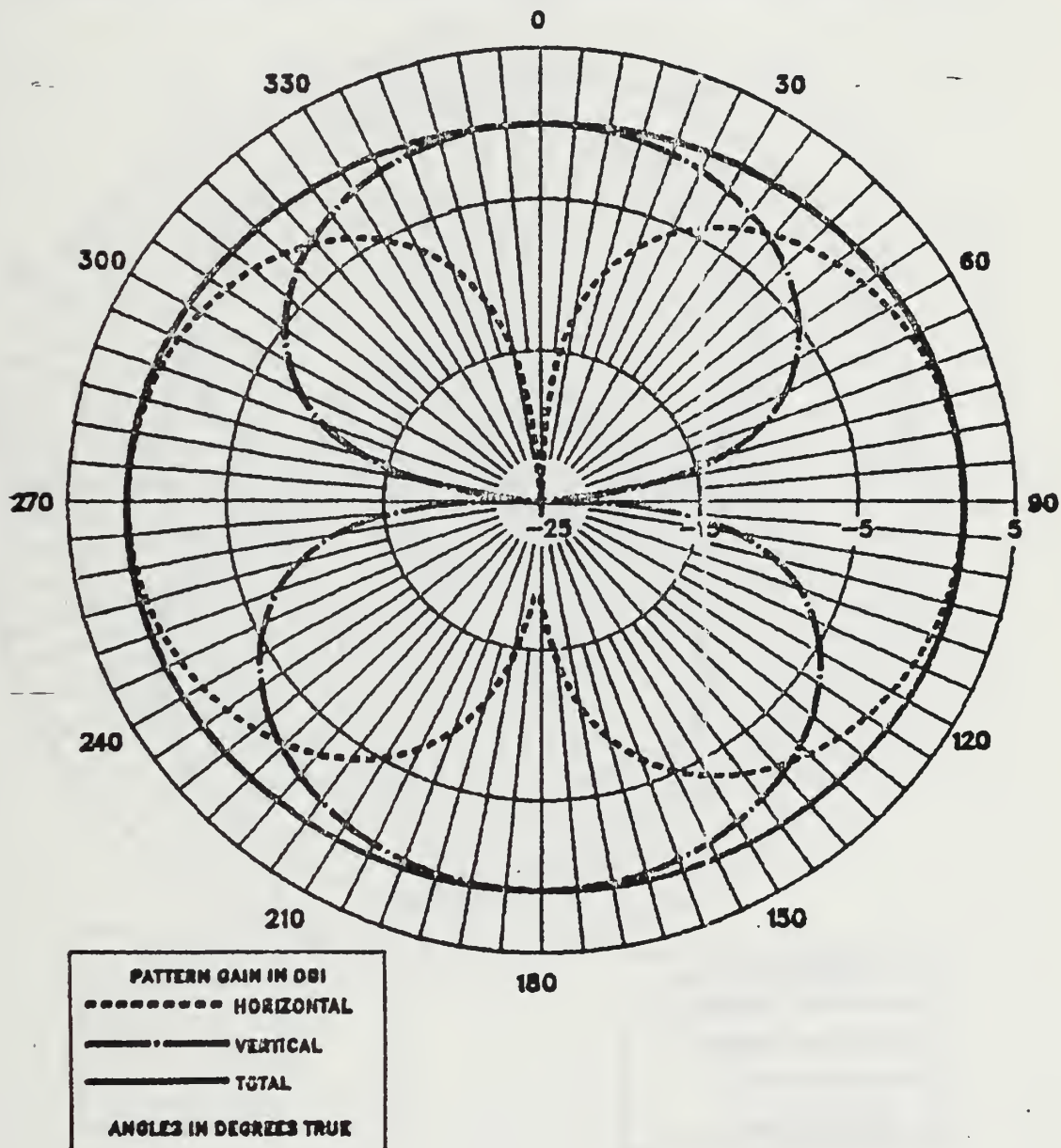
H65 IGUANA DATA RUN AT 7.645MHZ ON 8/22/87

ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CUT, THETA=90



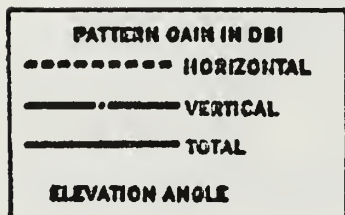
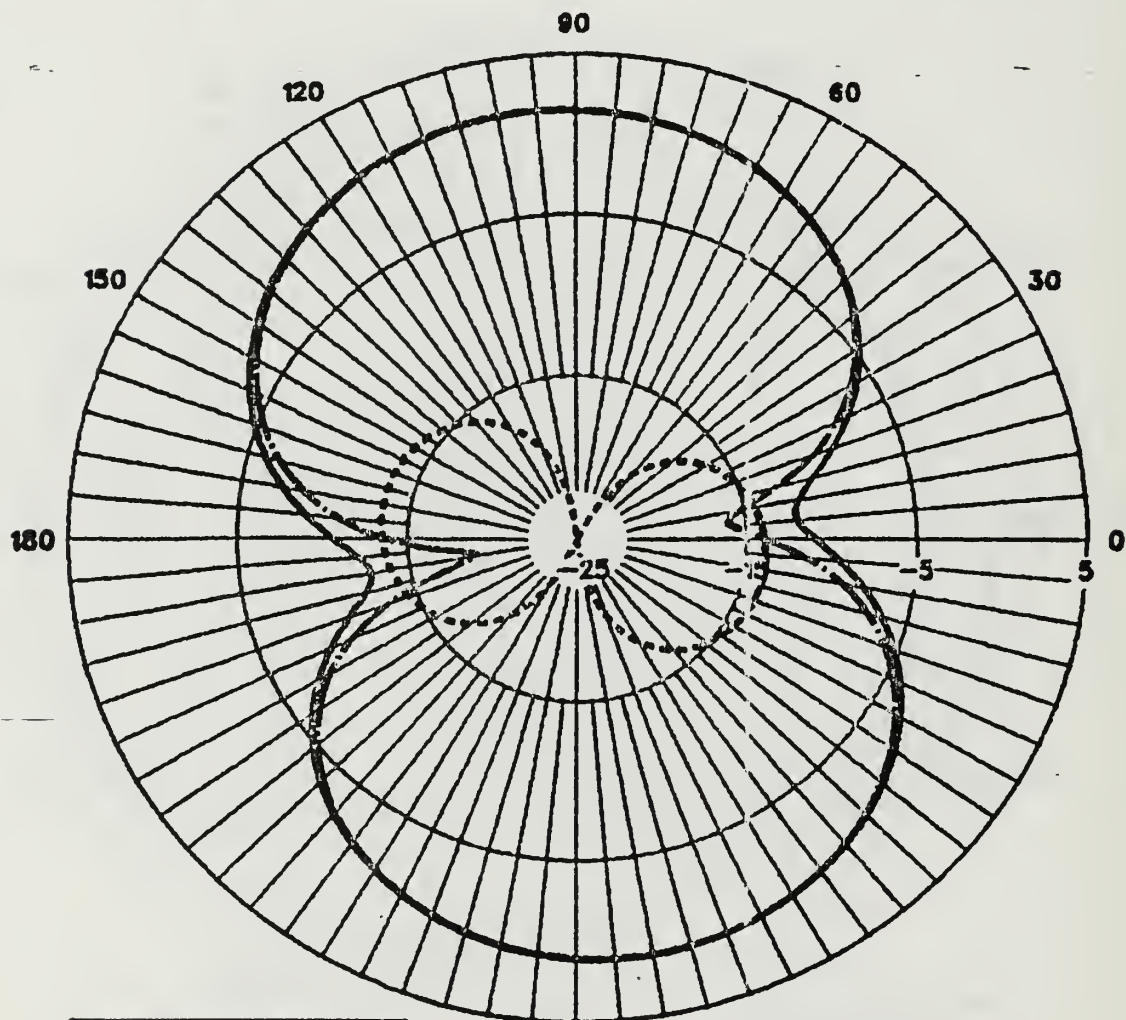
H65 IGUANA DATA RUN AT 7.645MHZ ON 8/22/87

ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CUT, THETA=26



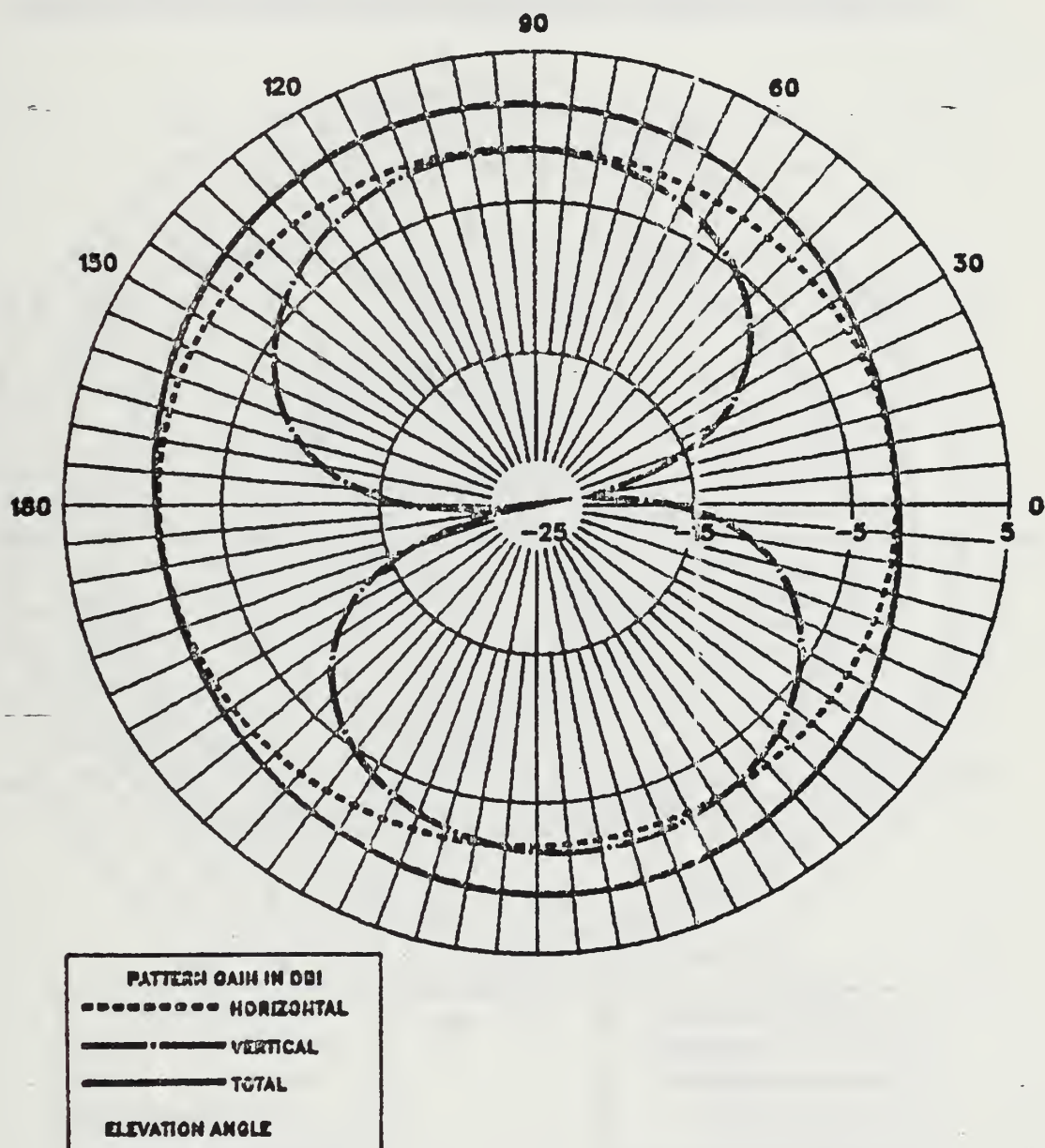
H65 IGUANA DATA RUN AT 7.645MHZ ON 8/22/87

ARMY-TYPE TUBE ANT, FREE SPACE, VERT CUT, PHI=0



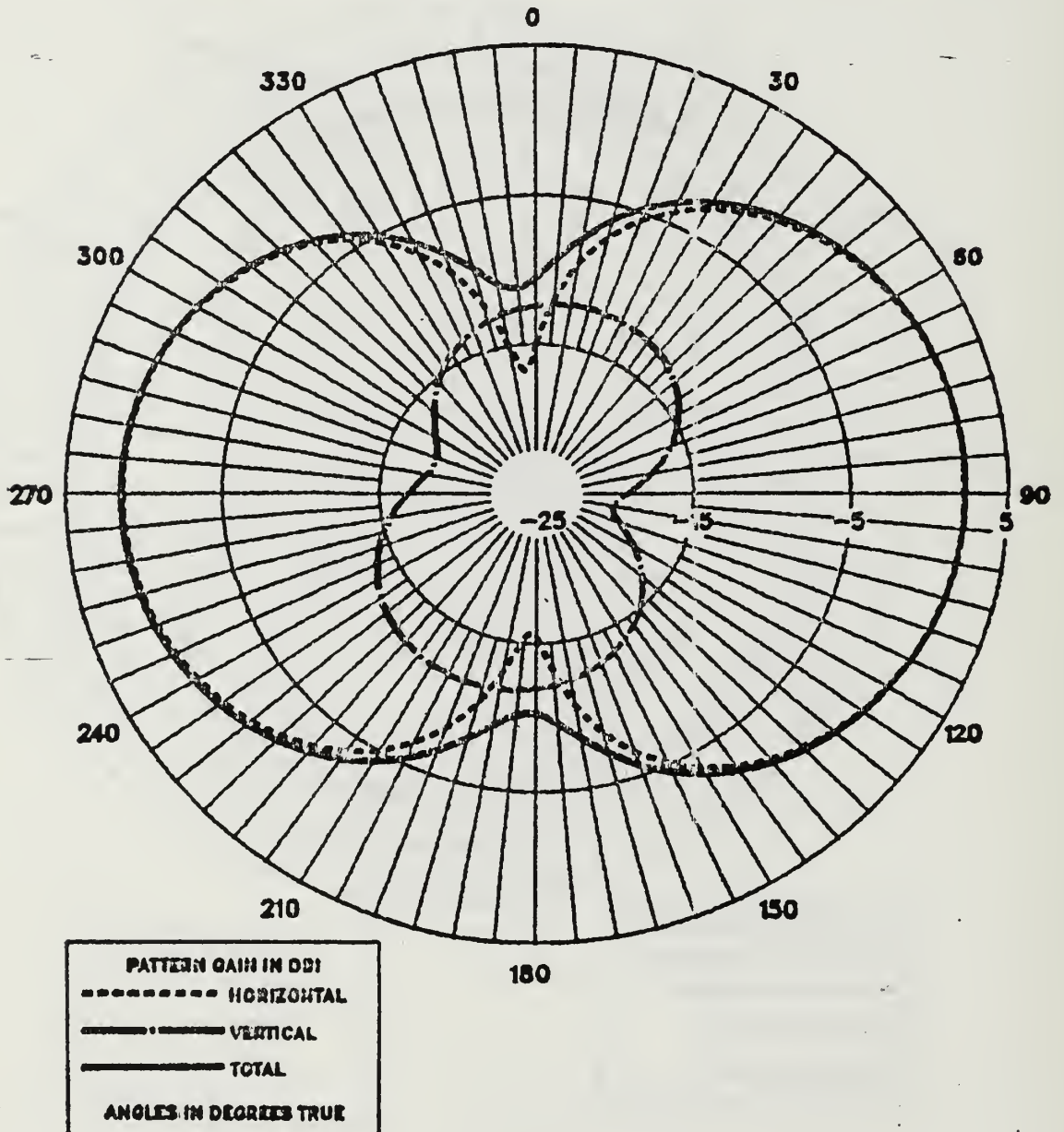
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ARMY-TYPE TUBE ANT, FREE SPACE, VERT CUT, PHI=45



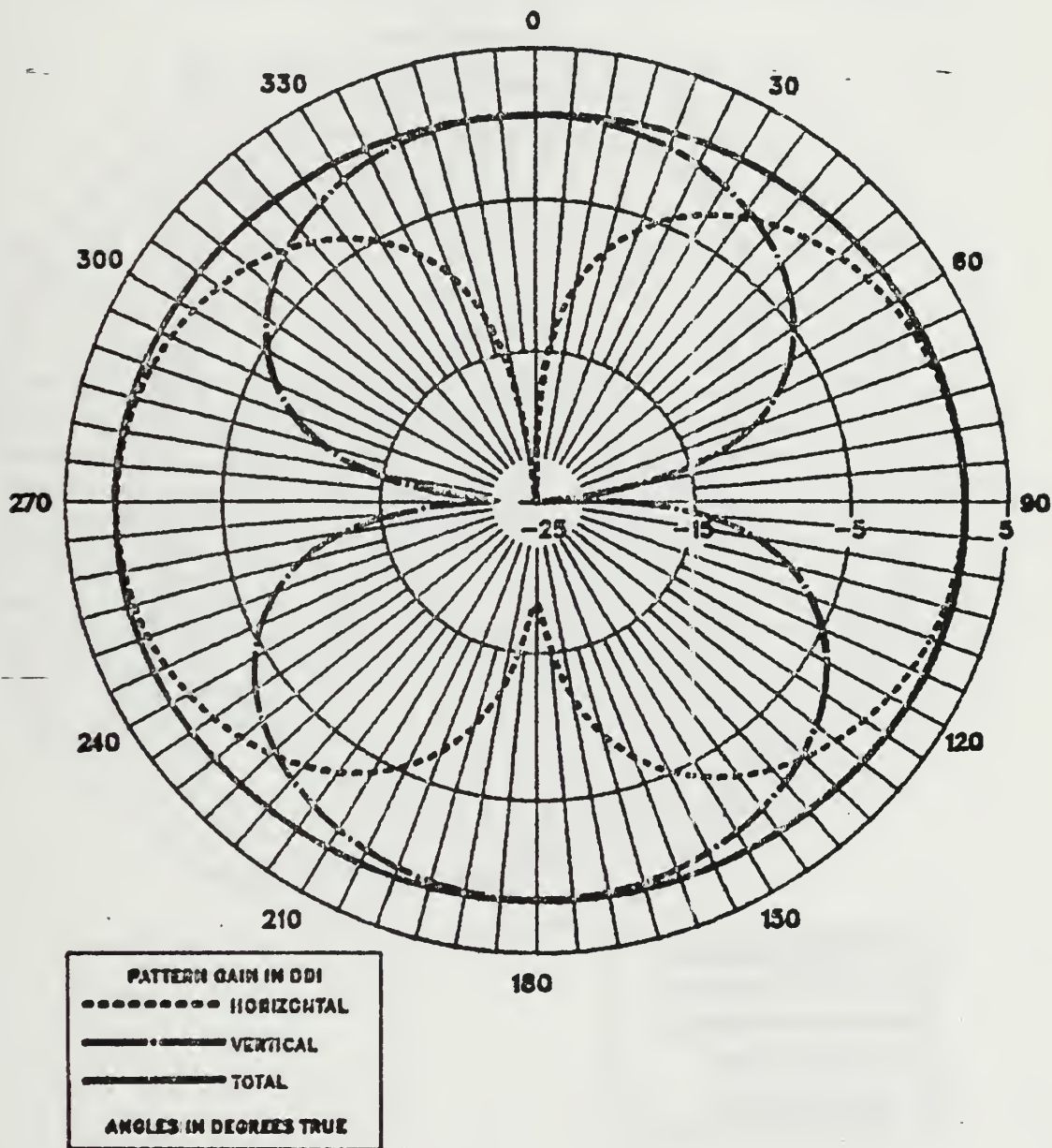
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LONG SHUNTED LOOP, FREE SPACE, HORIZ CUT, THETA=90



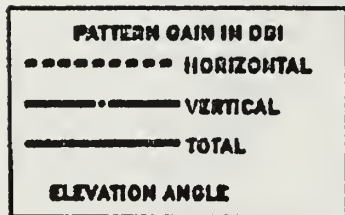
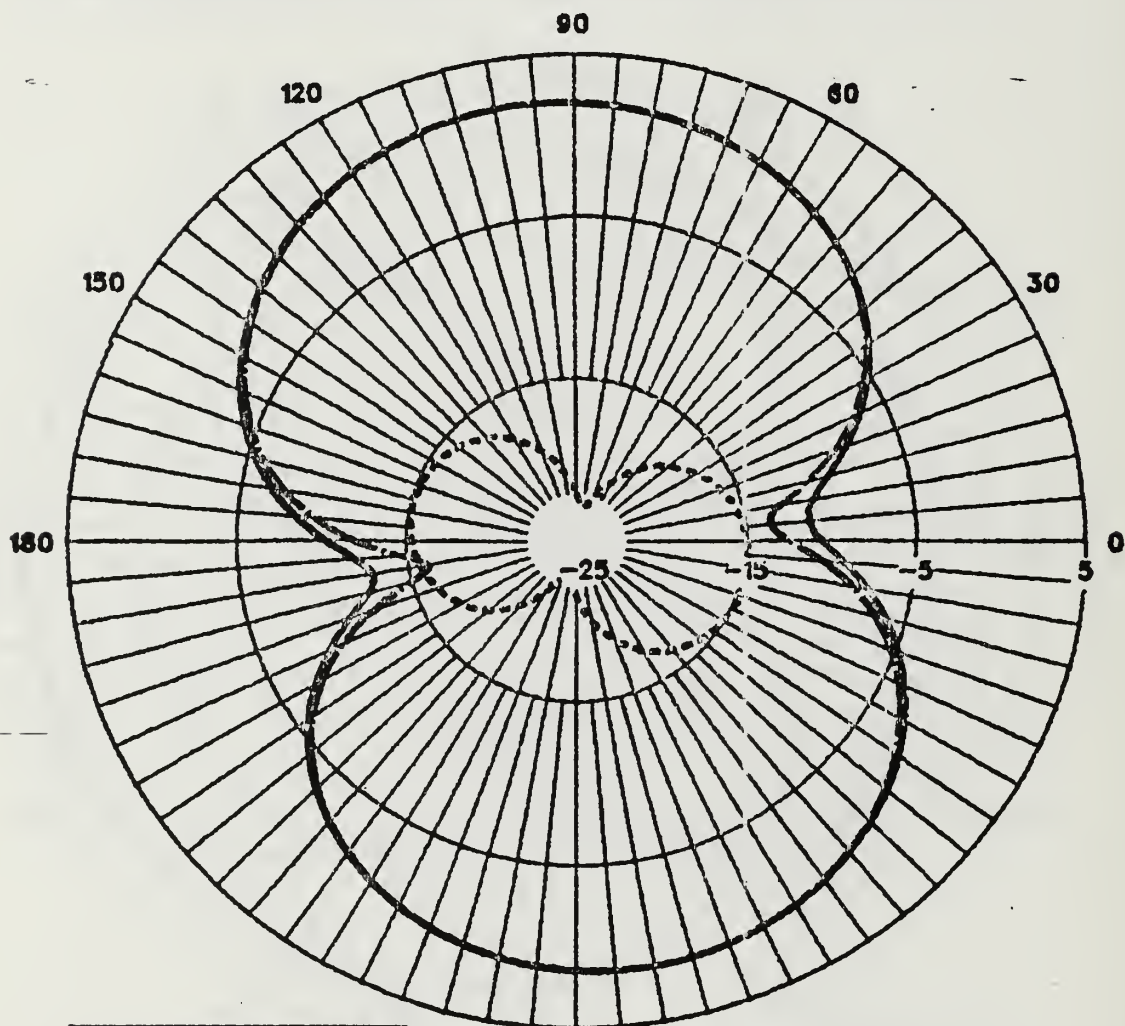
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LONG SHUNTED LOOP, FREE SPACE, HORIZ CUT, THETA=26



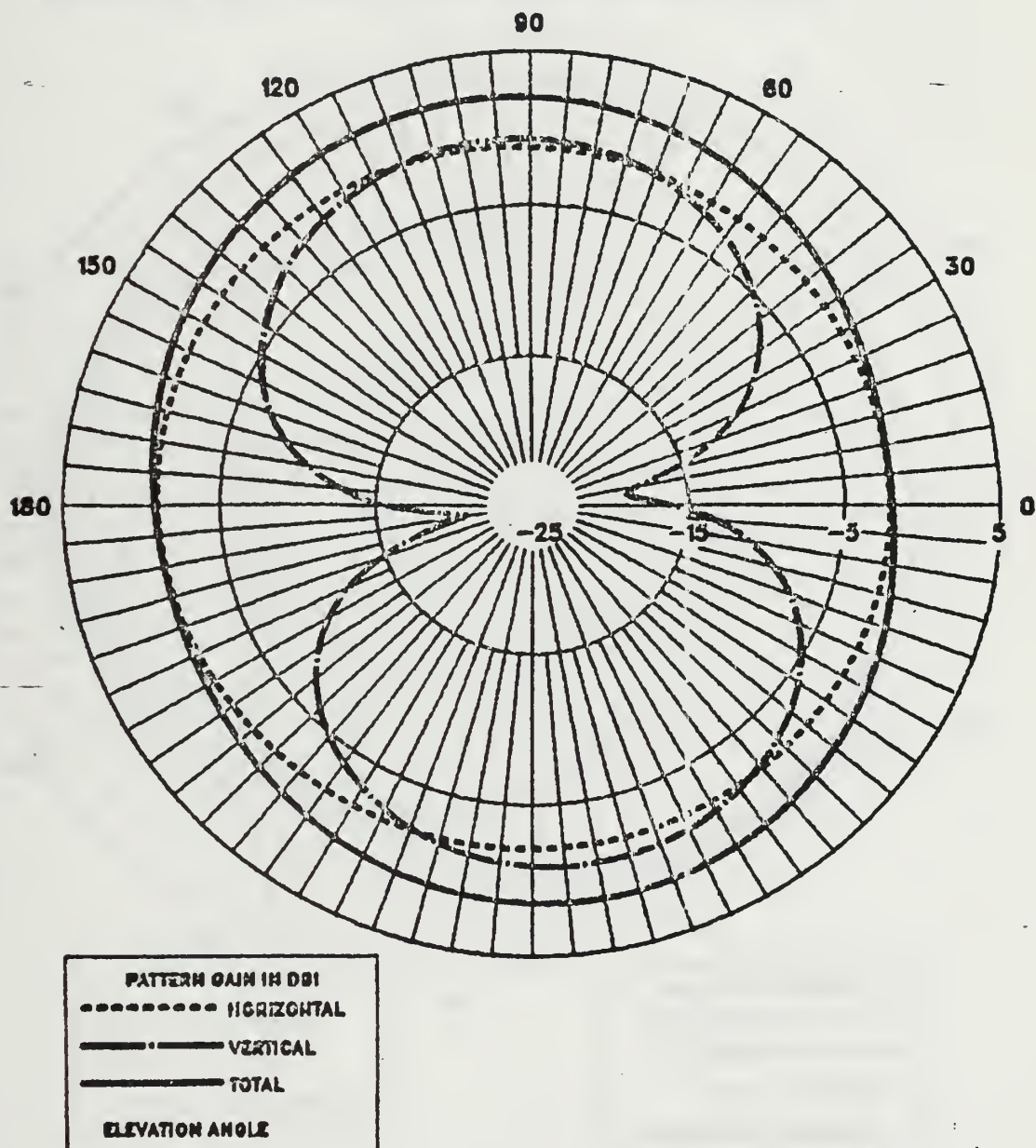
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LONG SHUNTED LOOP, FREE SPACE, VERT CUT, PHI=0



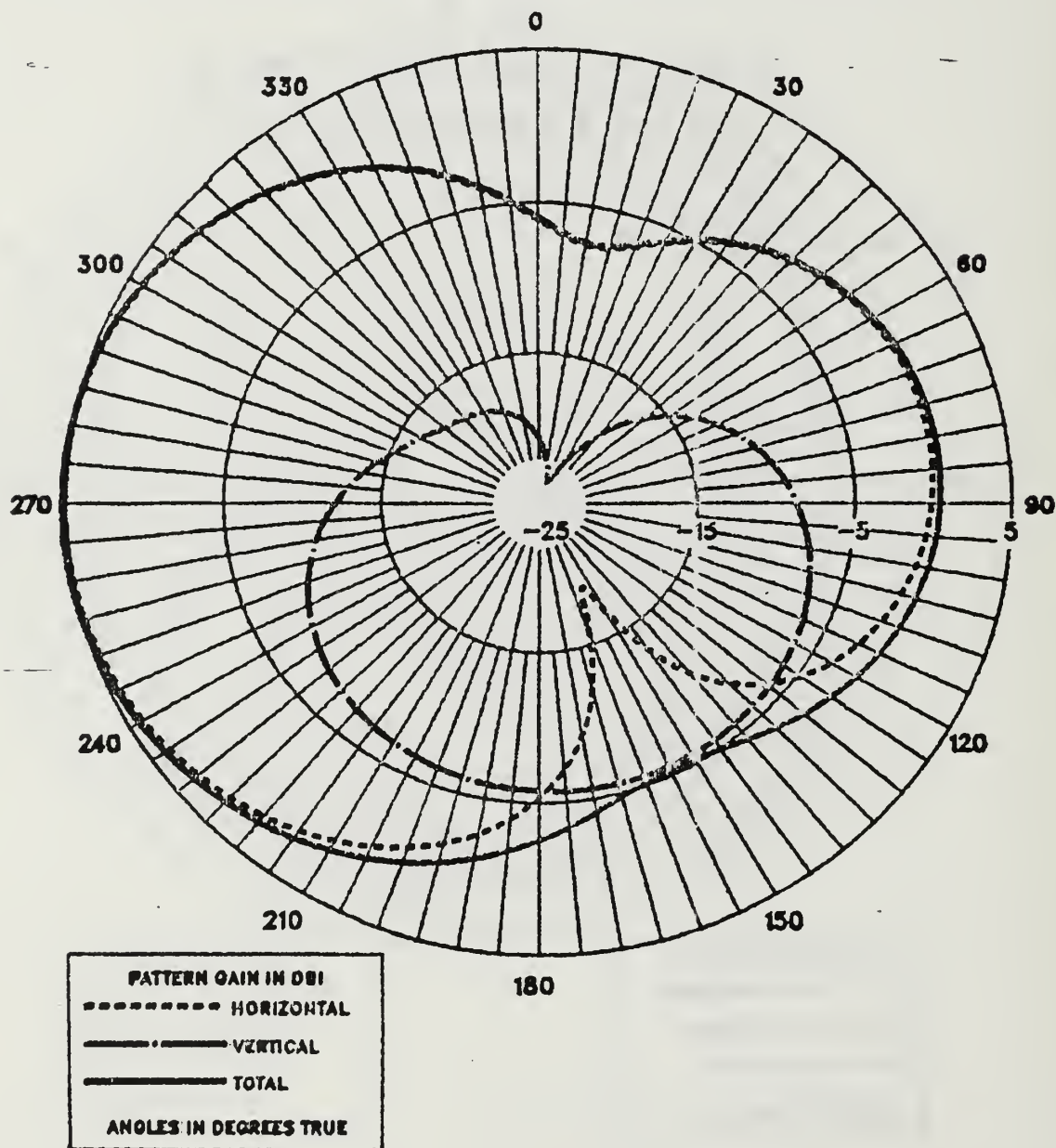
H65 IGUANA DATA RUN AT 7.645MHZ ON 8/22/87

LONG SHUNTED LOOP, FREE SPACE, VERT CUT, $\Phi=45$



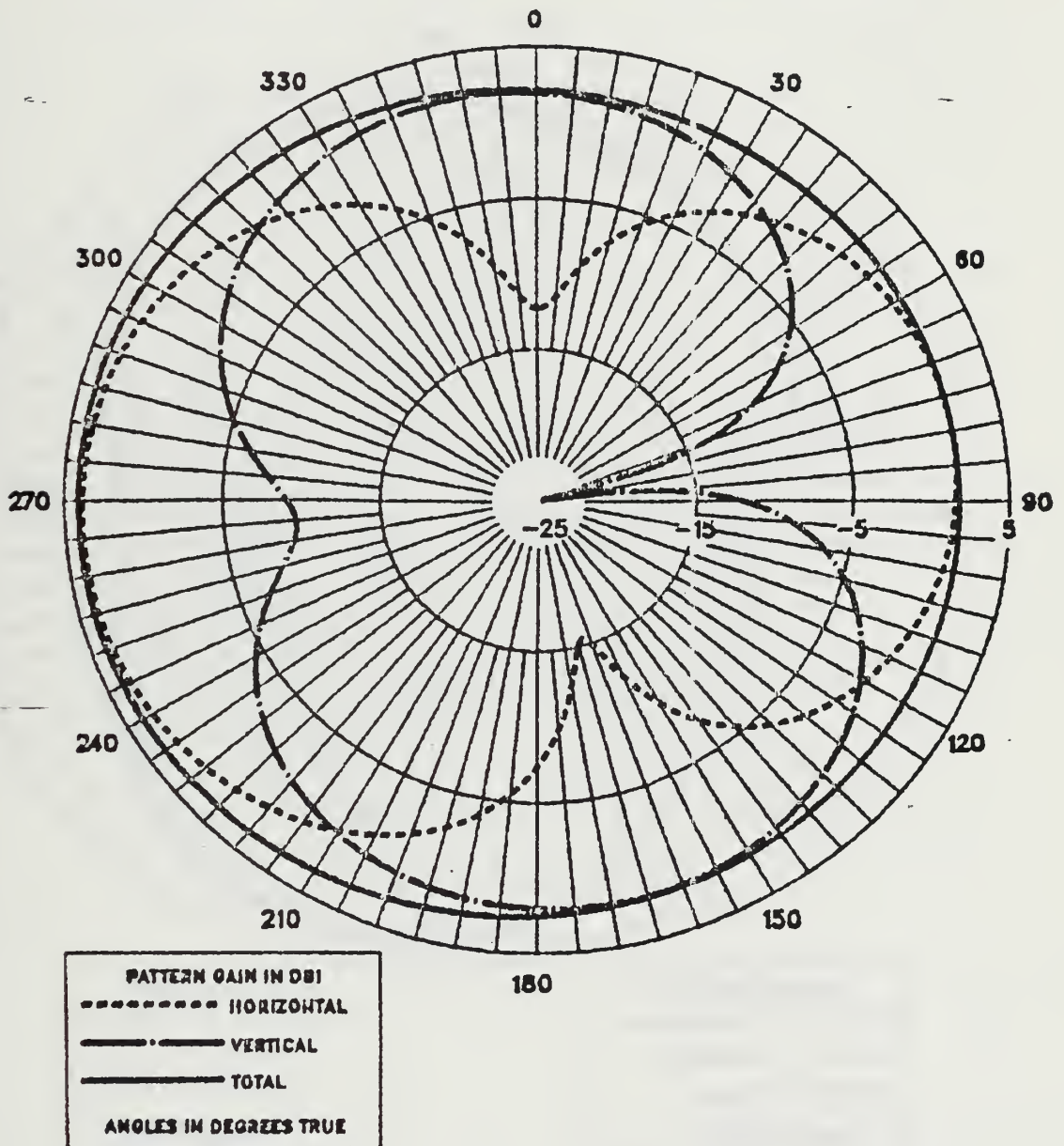
H65 IGUANA DATA RUN AT 8.984MHZ ON 8/24/87

LONG-WIRE ANT, FREE SPACE, HORIZ CUT, THETA=90



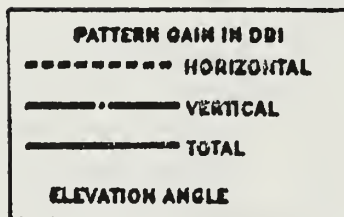
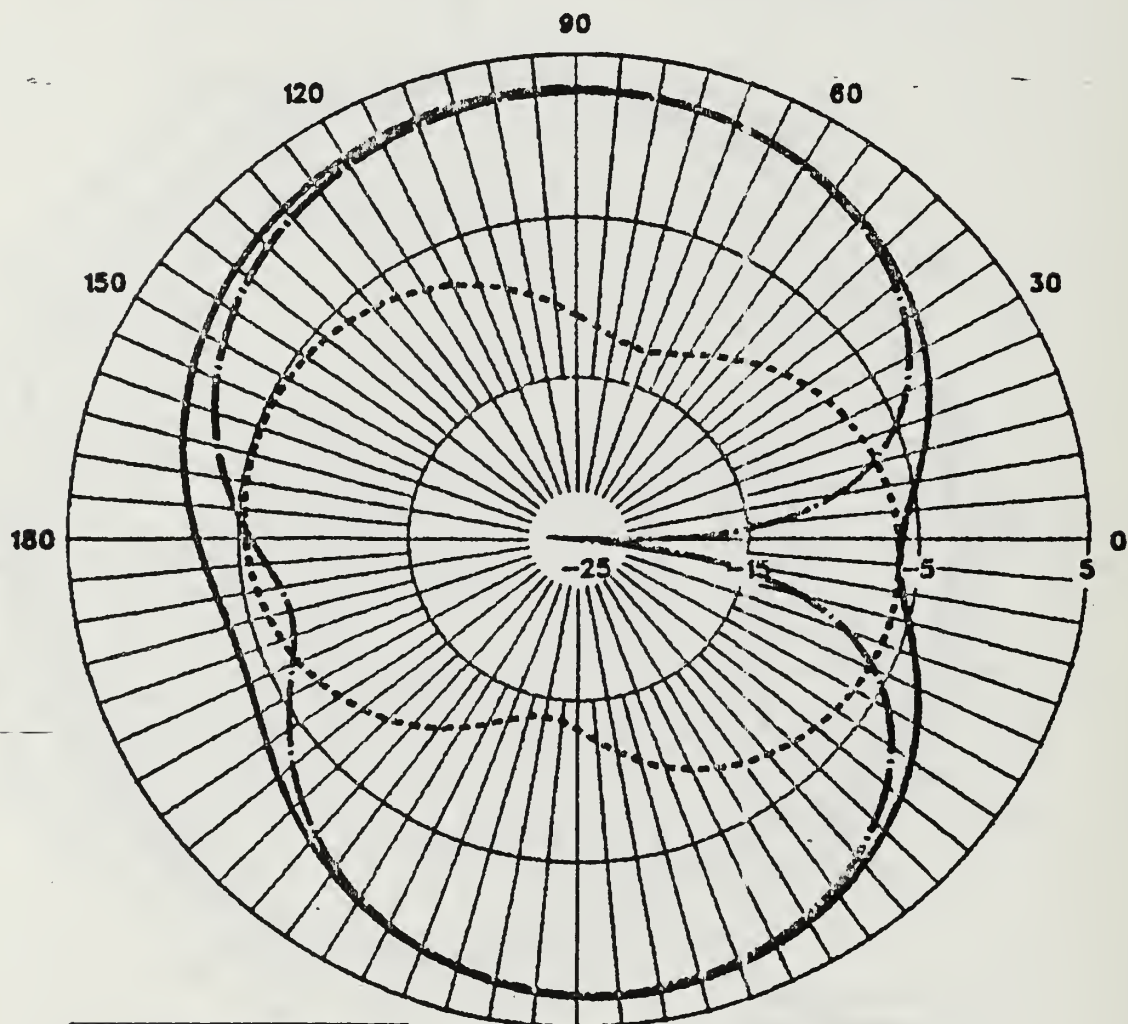
H65 IGUANA DATA RUN AT 8.984MHZ ON 8/24/87

LONG-WIRE ANT, FREE SPACE, HORIZ CUT, THETA=26



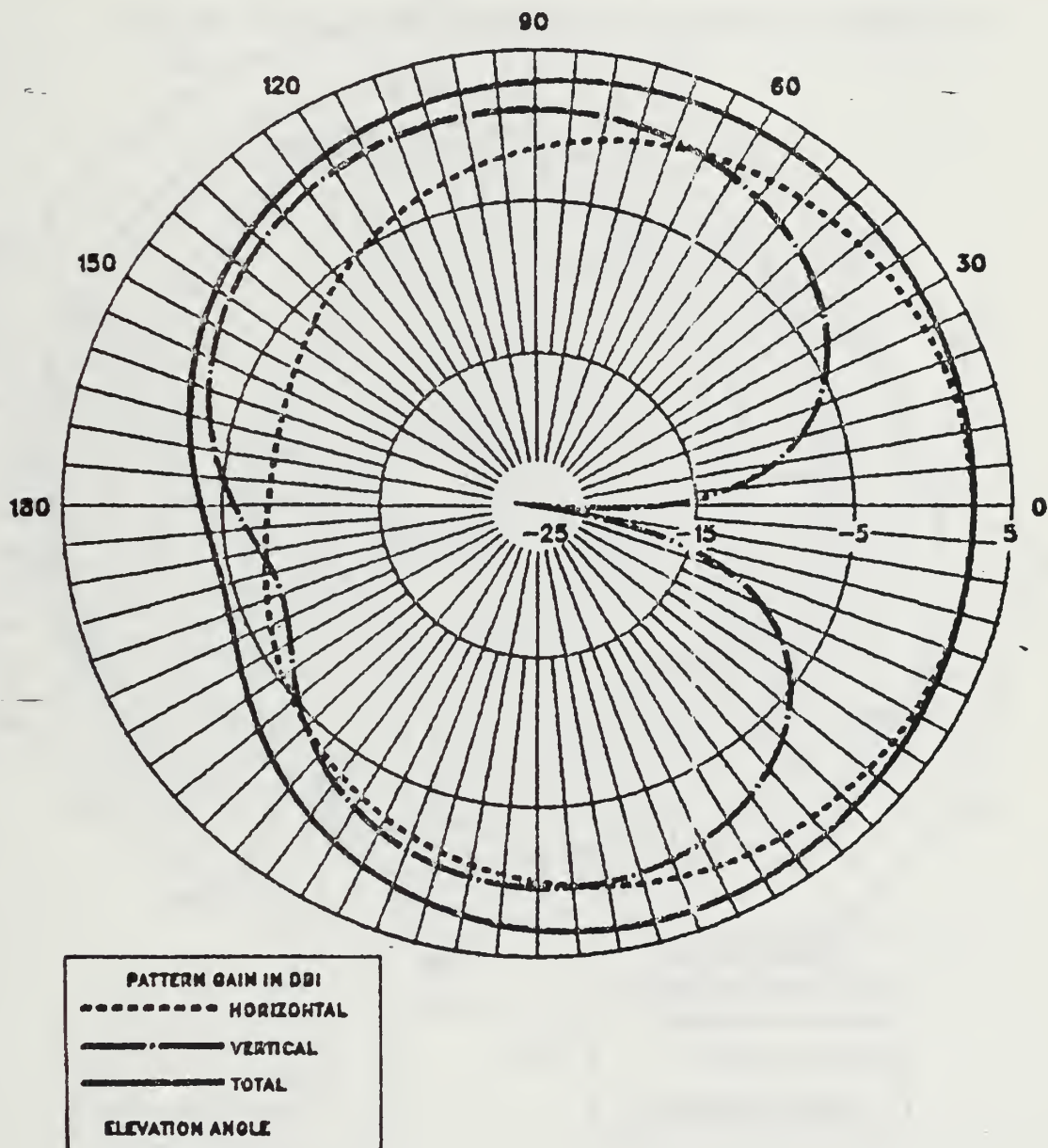
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LONG-WIRE ANT, FREE SPACE, VERT CUT, PHI=0



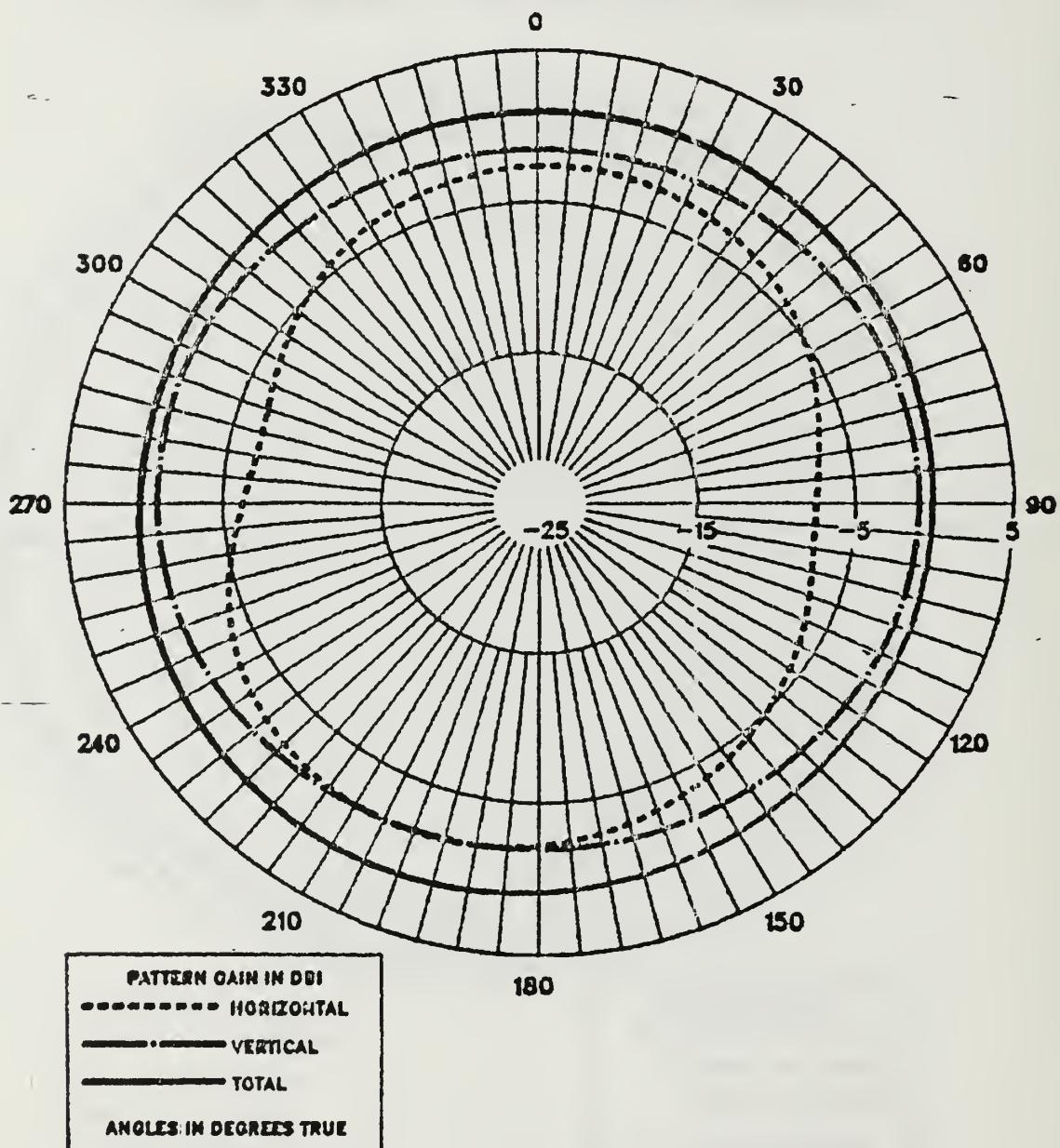
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LONG-WIRE ANT, FREE SPACE, VERT CUT, PHI=45



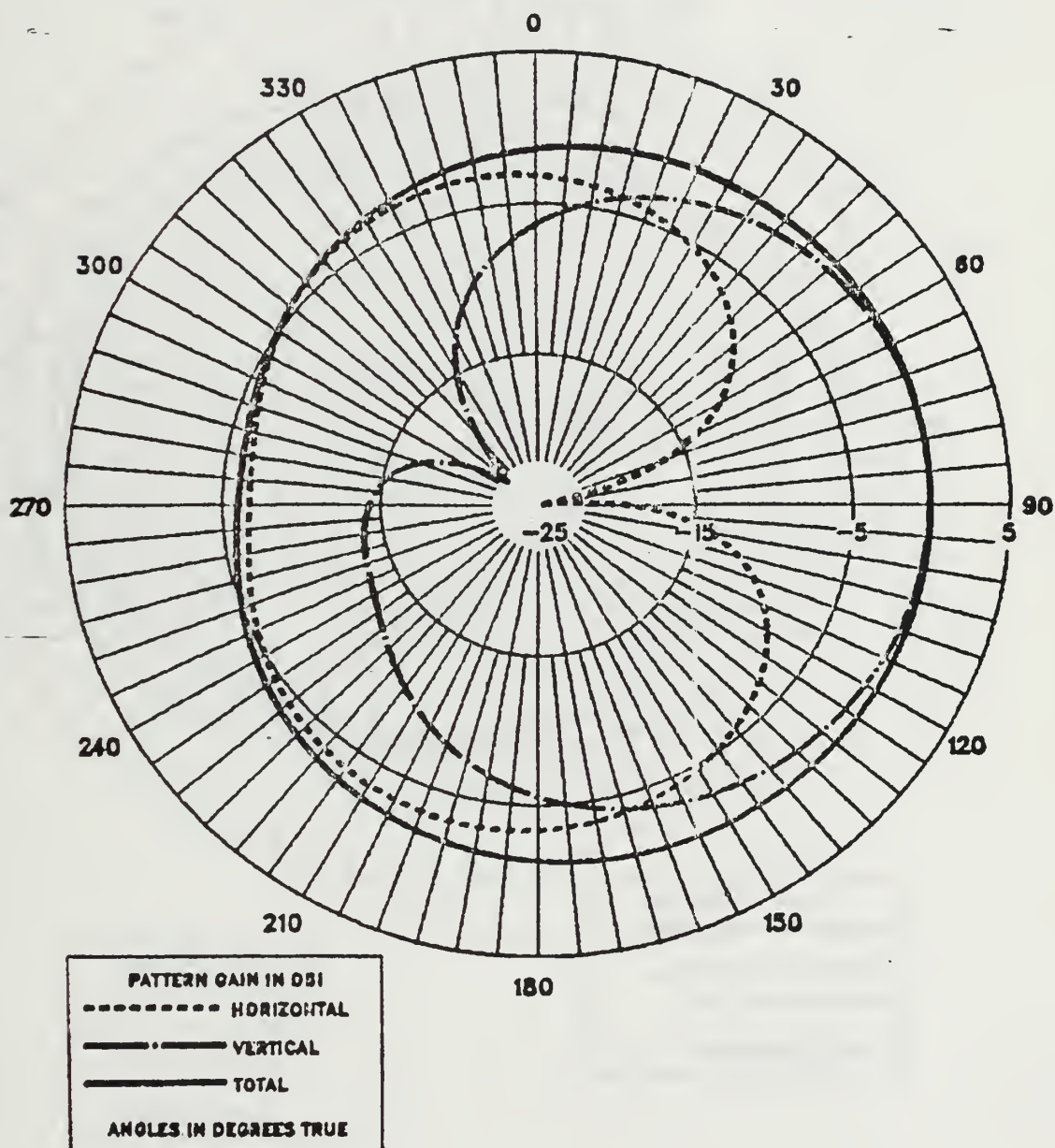
H65 IGUANA DATA RUN AT 8.984MHZ ON 8/24/87

COLLINS 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=90



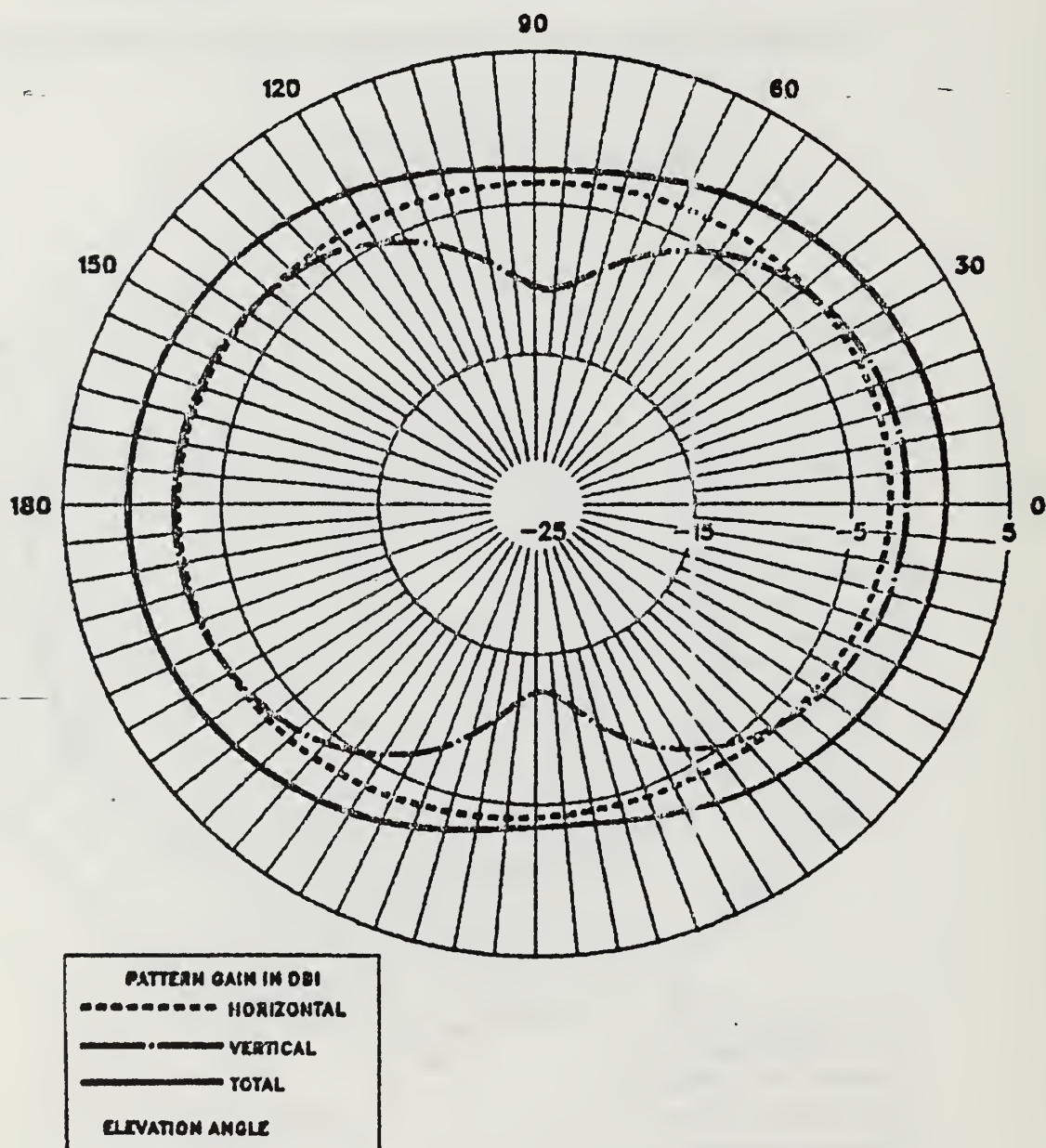
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COLLINS 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=26



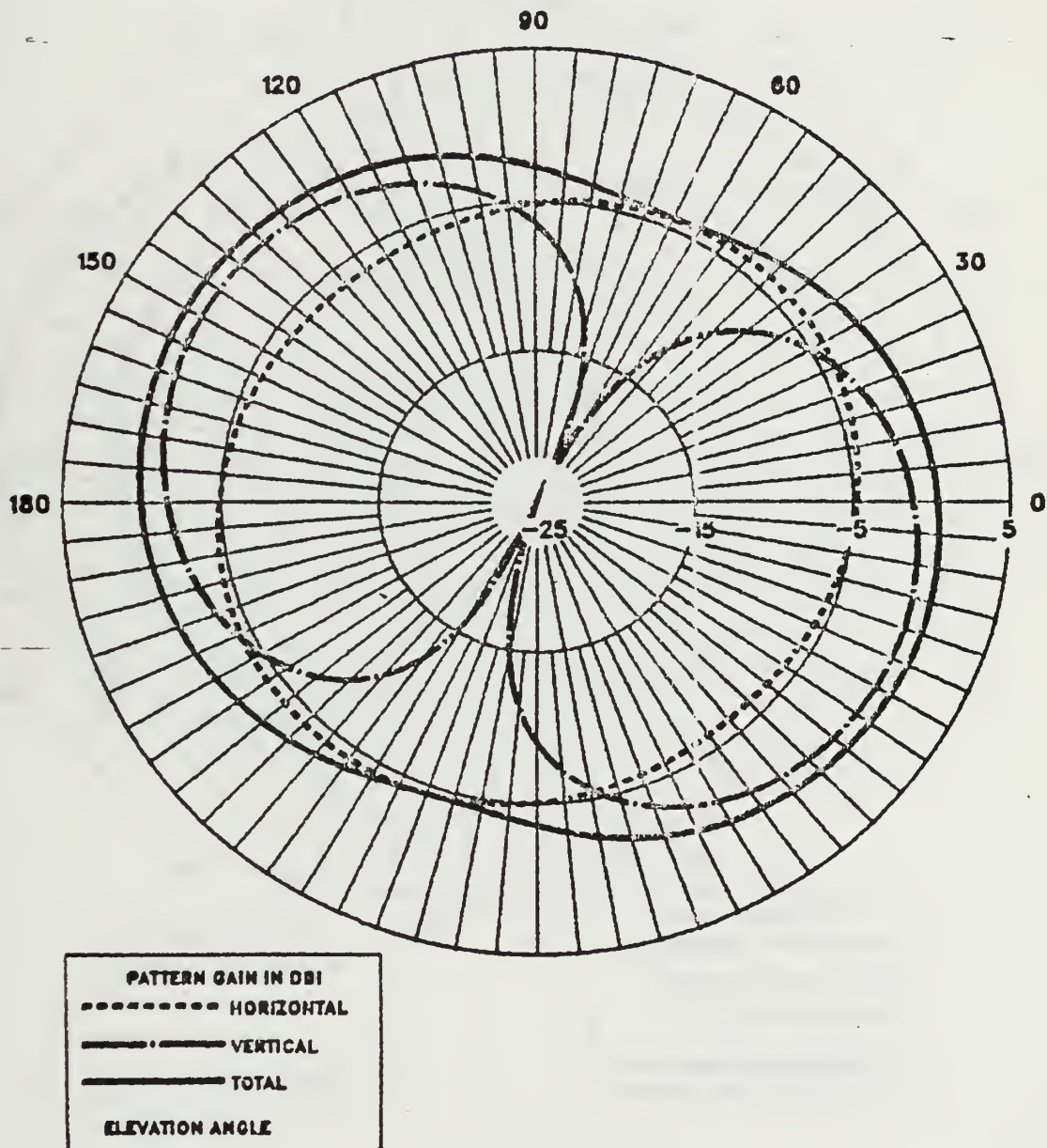
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COLLINS 437R-2 ANT, FREE SPACE, VERT CUT, PHI=0



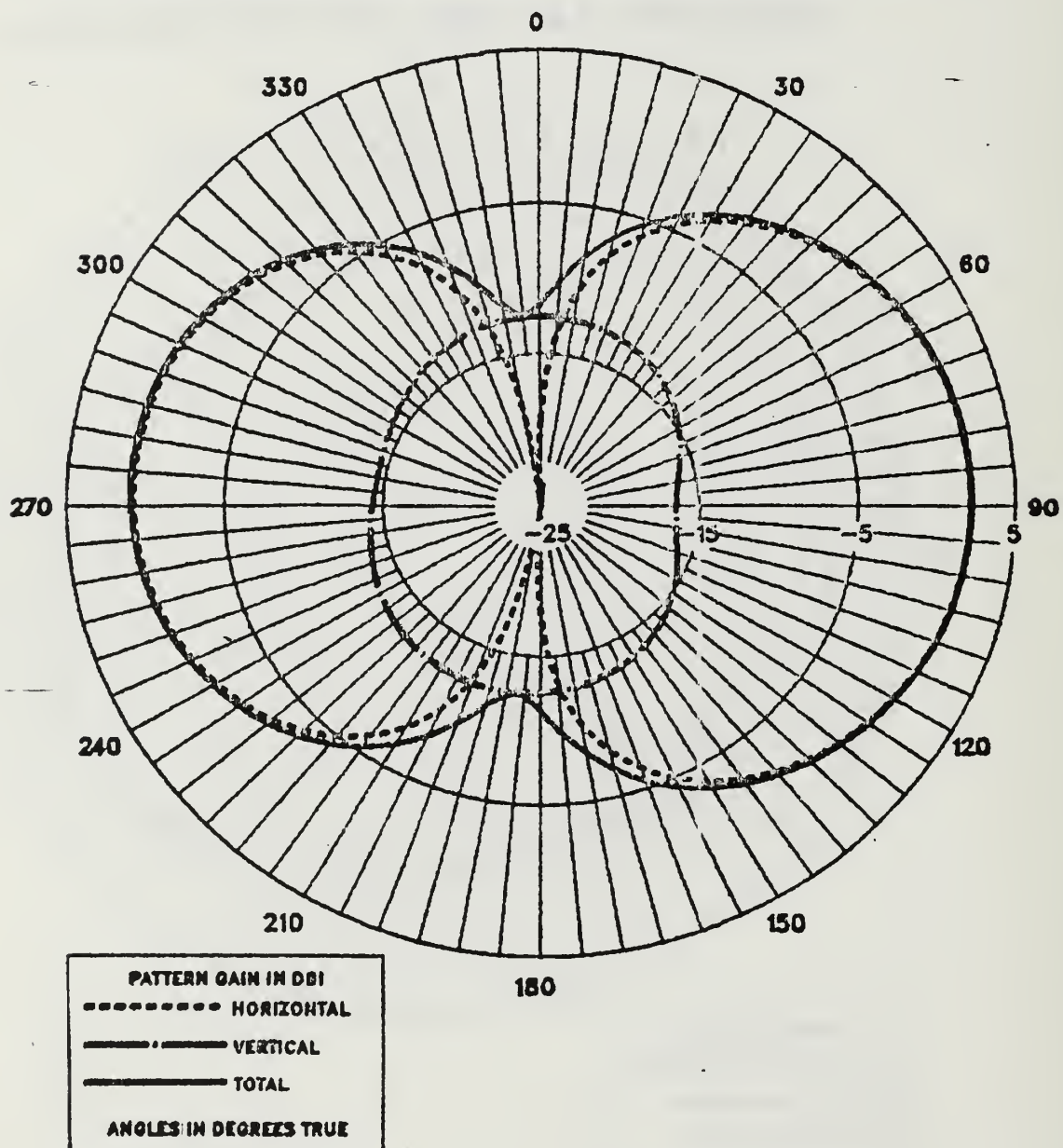
H65 IGUANA DATA RUN AT 8.984MHZ ON 8/24/87

COLLINS 437R-2 ANT, FREE SPACE, VERT CUT, $\Phi=45$



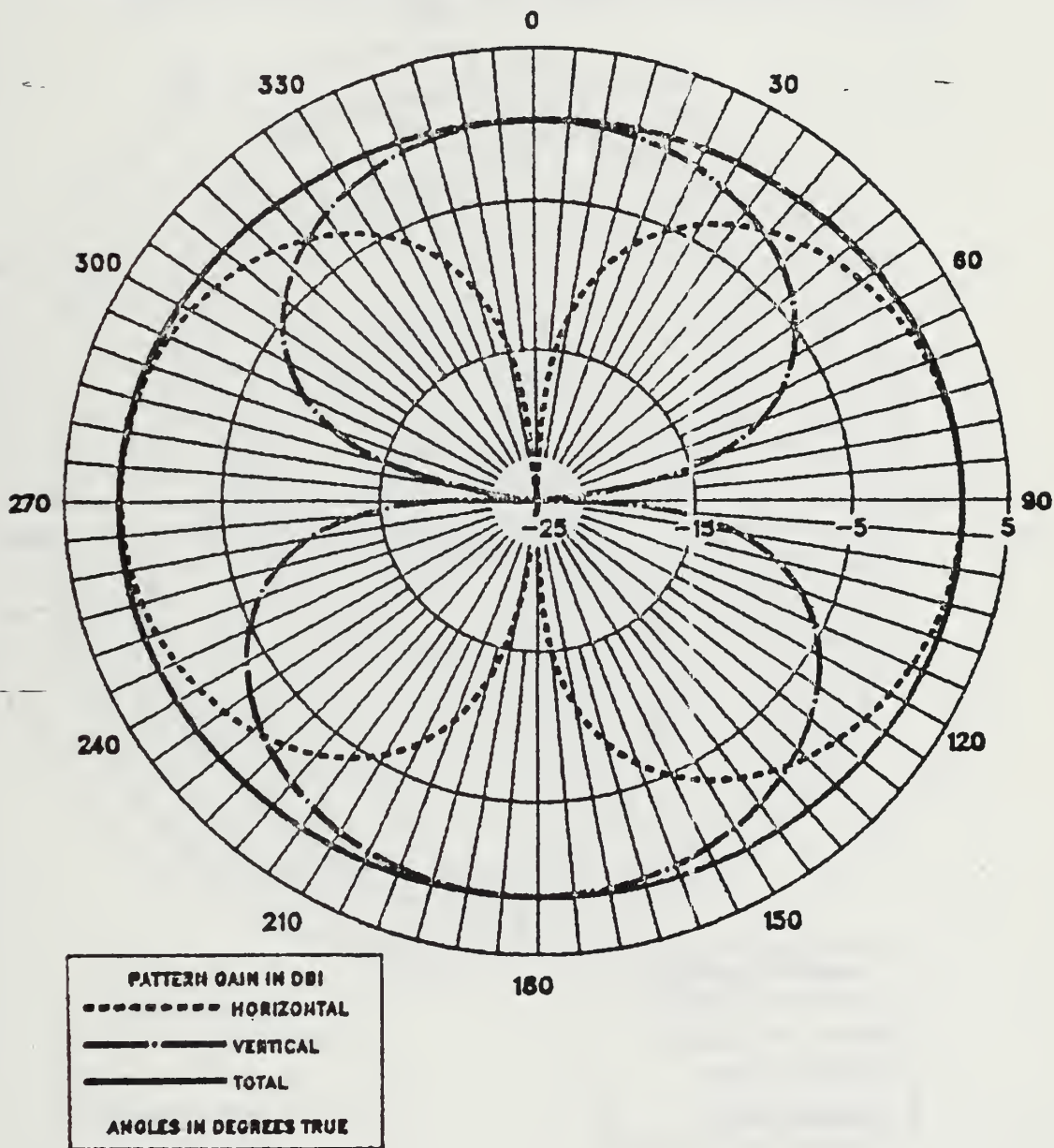
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ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CUT, THETA=90



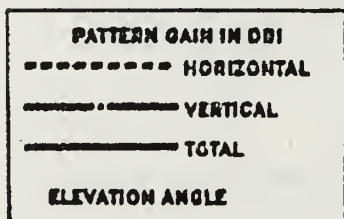
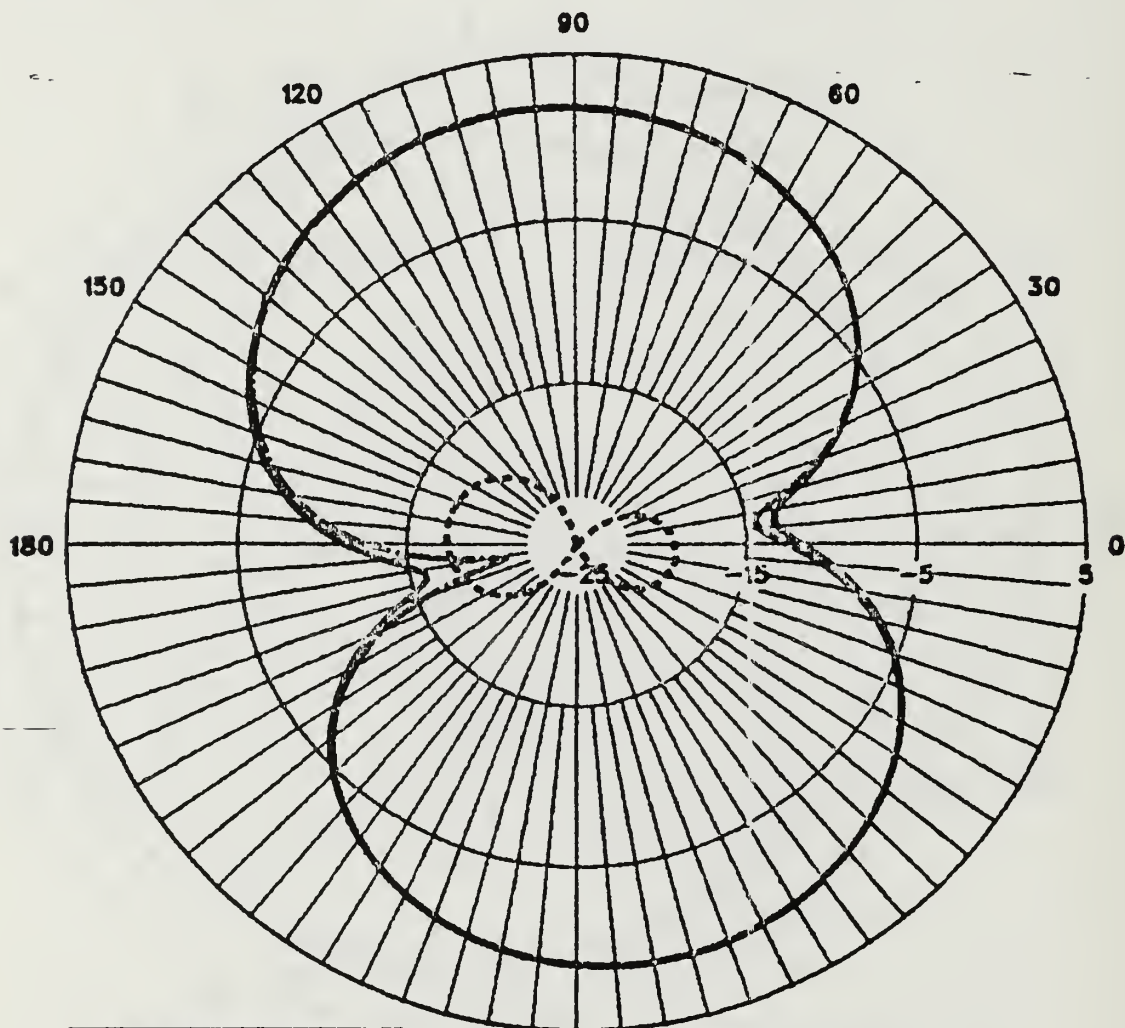
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ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CUT, THETA=26



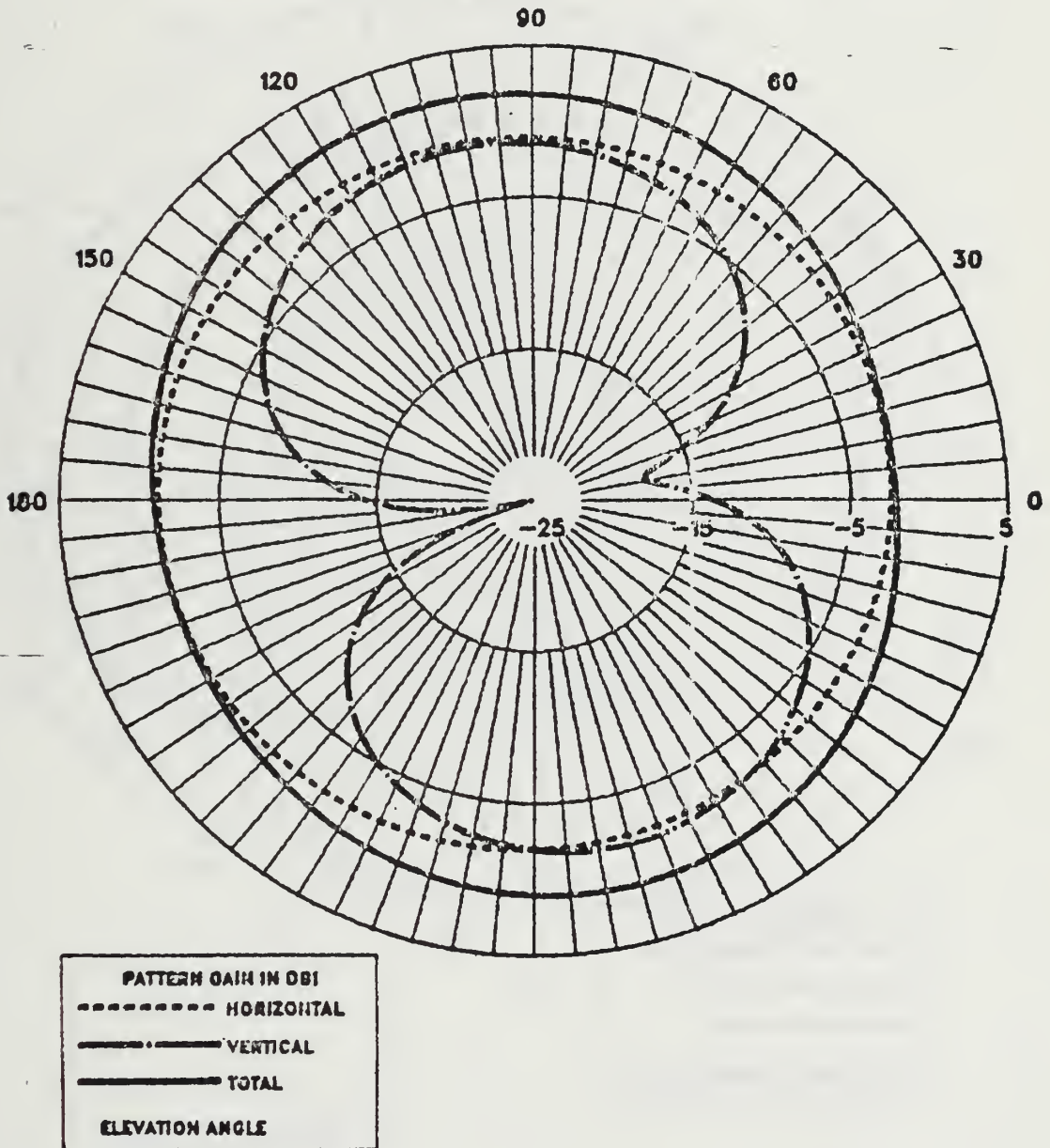
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ARMY-TYPE TUBE ANT, FREE SPACE, VERT CUT, PHI=0



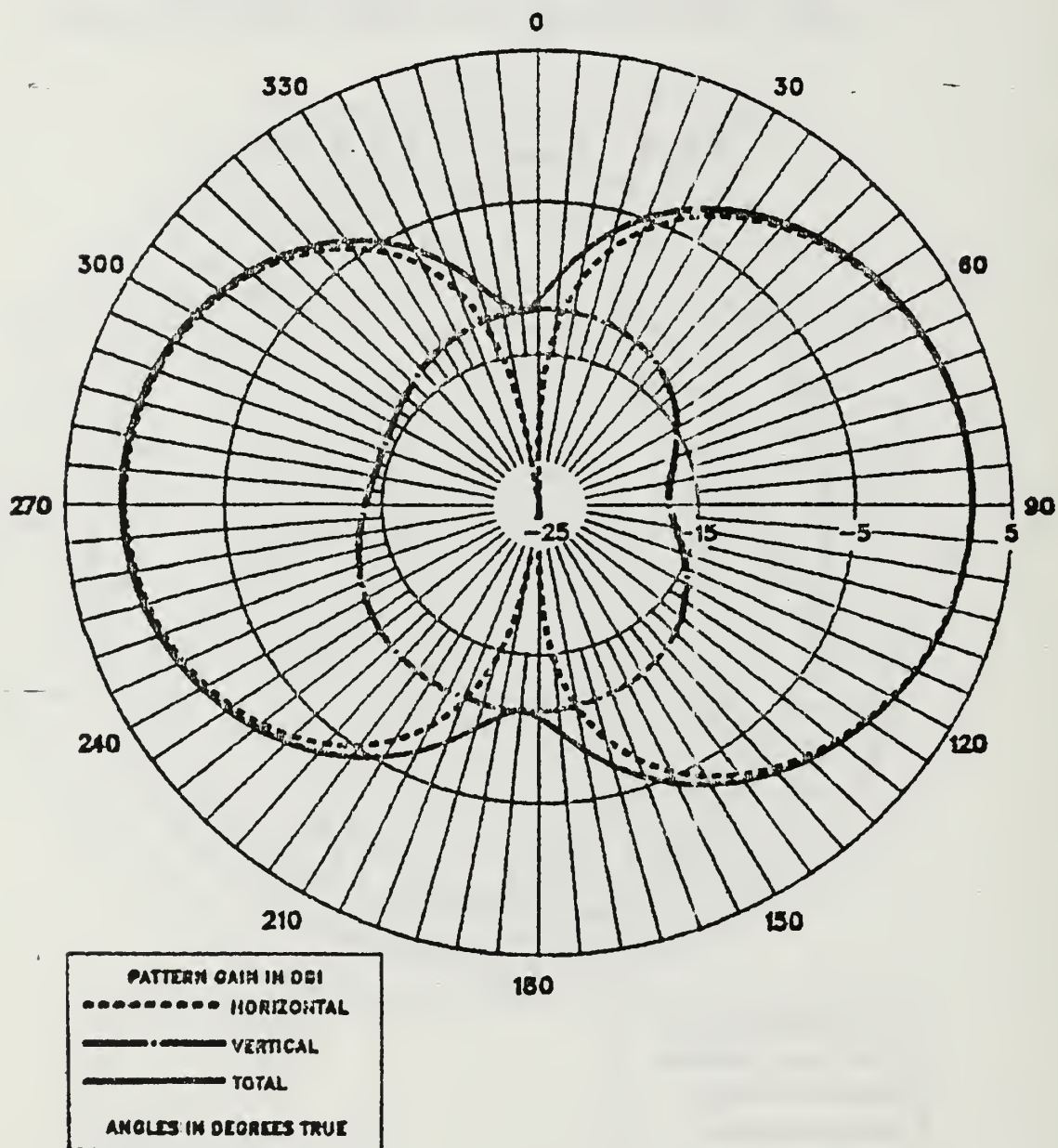
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ARMY-TYPE TUBE ANT, FREE SPACE, VERT CUT, PHI=45



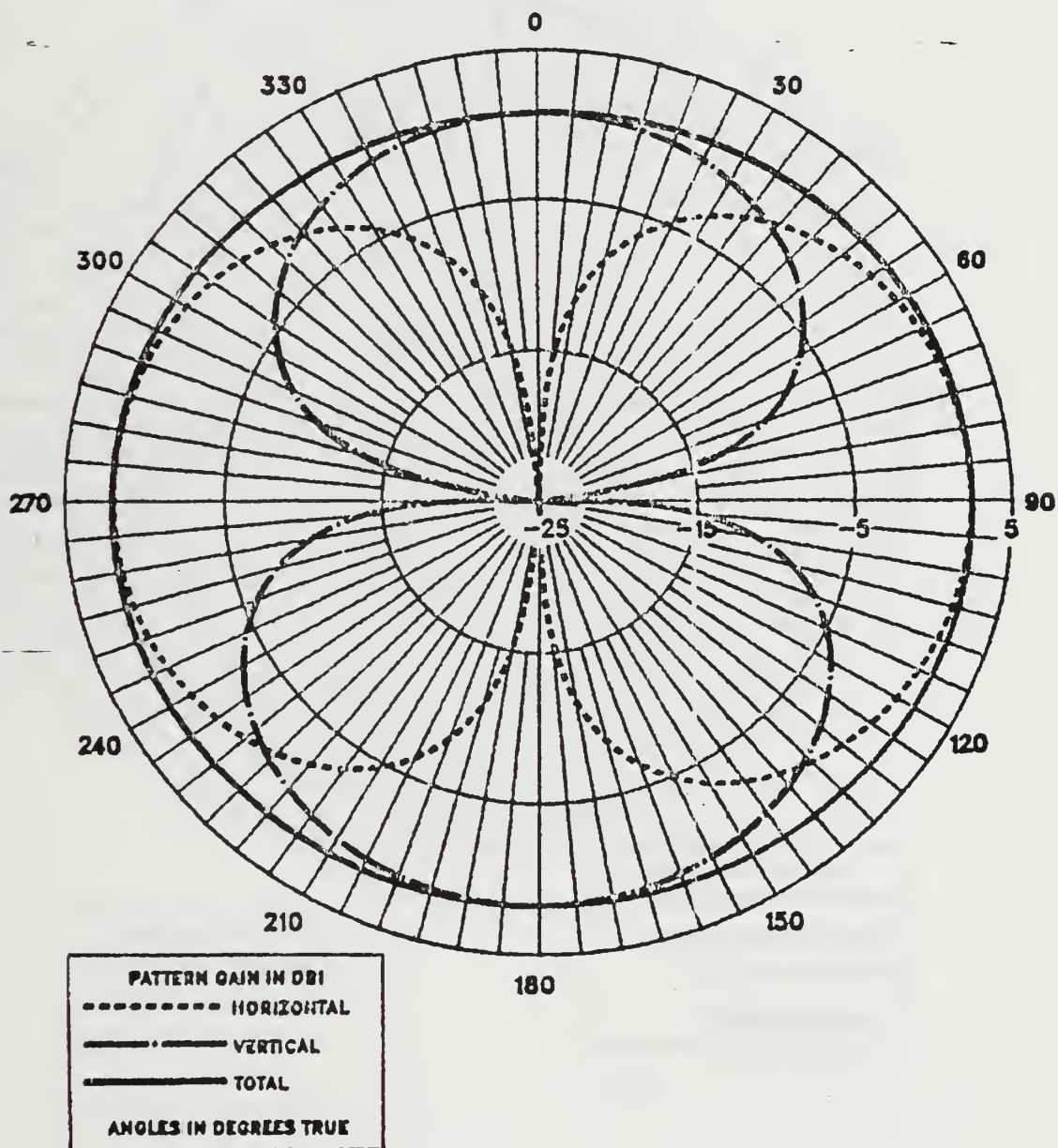
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LONG SHUNTED LOOP, FREE SPACE, HORIZ CUT, THETA=90



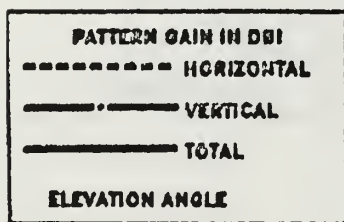
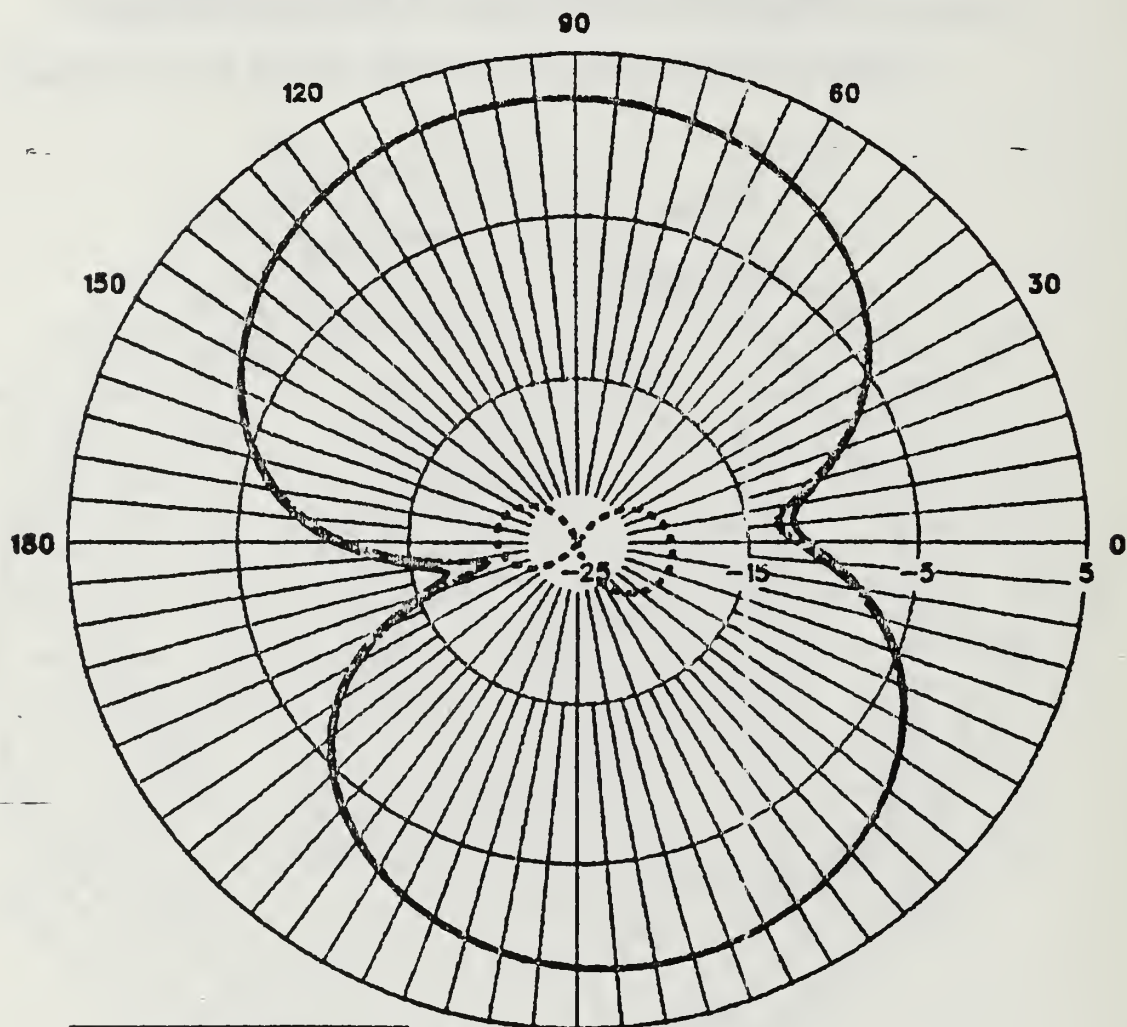
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LONG SHUNTED LOOP, FREE SPACE, HORIZ CUT, THETA=26



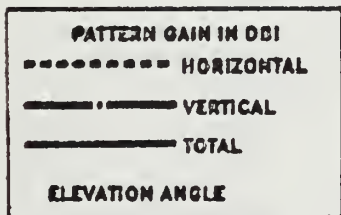
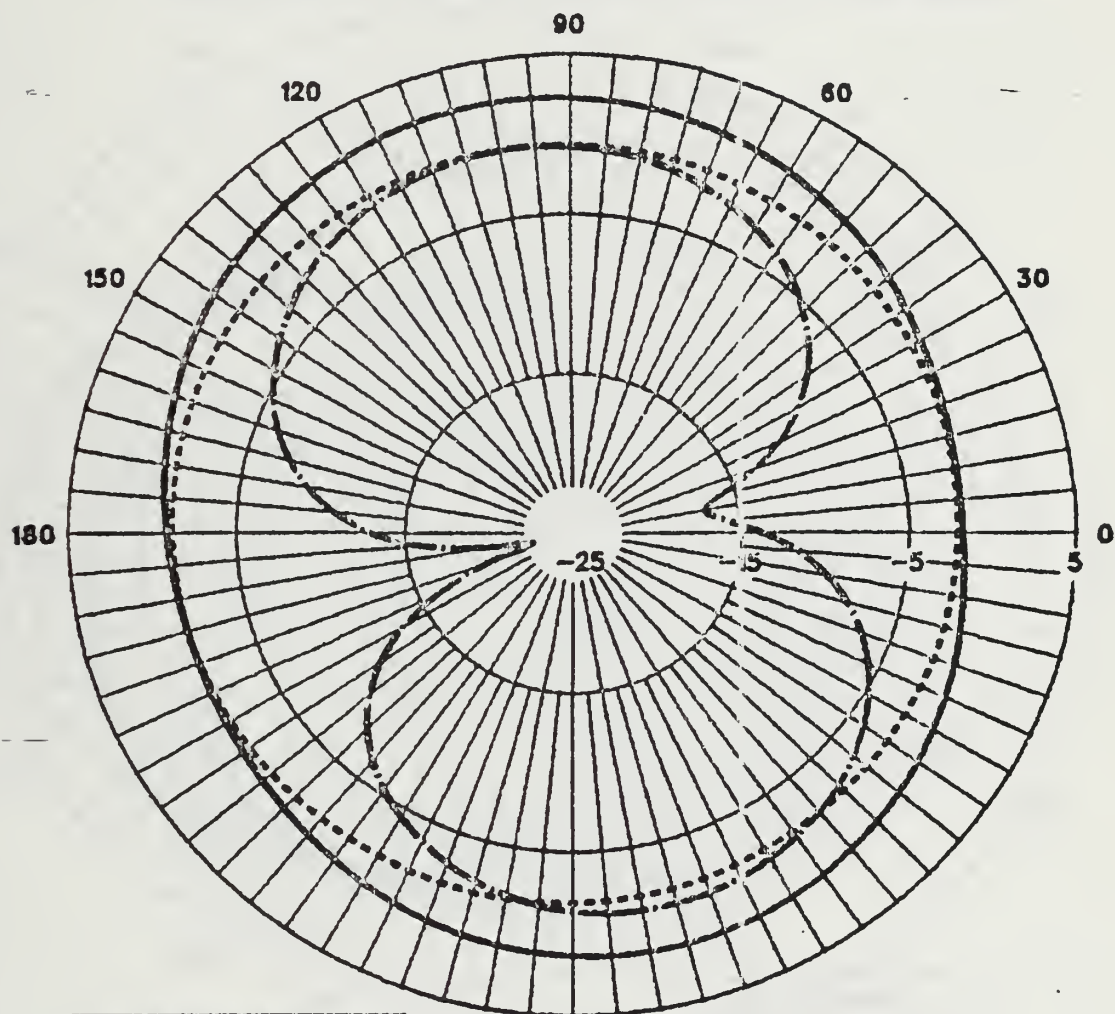
H65 IGUANA DATA RUN AT 8.984MHZ ON 8/24/87

LONG SHUNTED LOOP, FREE SPACE, VERT CUT, PHI=0



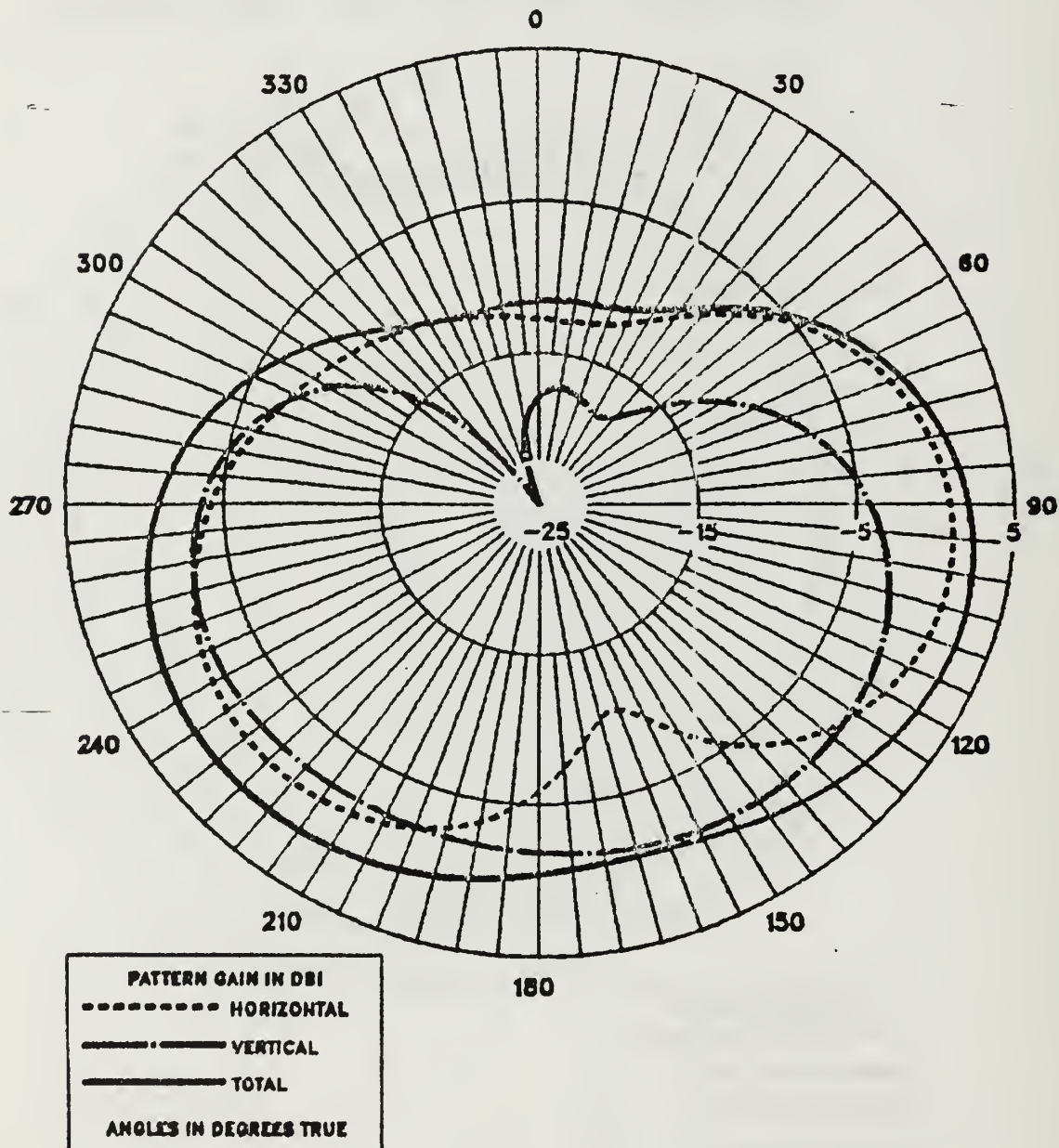
H65 IGUANA DATA RUN AT 8.984MHZ ON 8/24/87

LONG SHUNTED LOOP, FREE SPACE, VERT CUT, $\Phi=45$



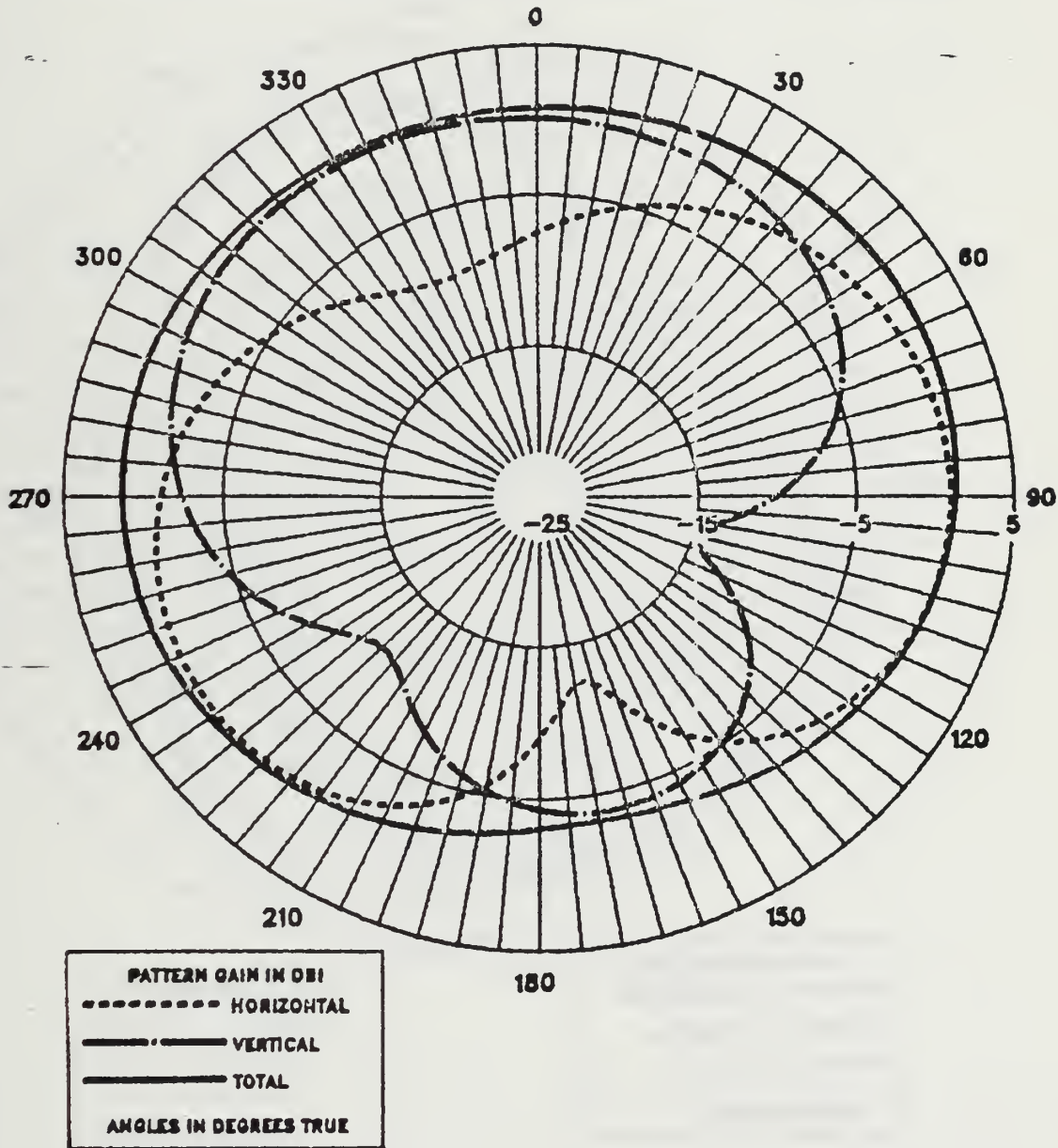
H65 IGUANA DATA RUN AT 13.974MHZ ON 8/25/87

LONG-WIRE ANT, FREE SPACE, HORIZ CUT, THETA=90



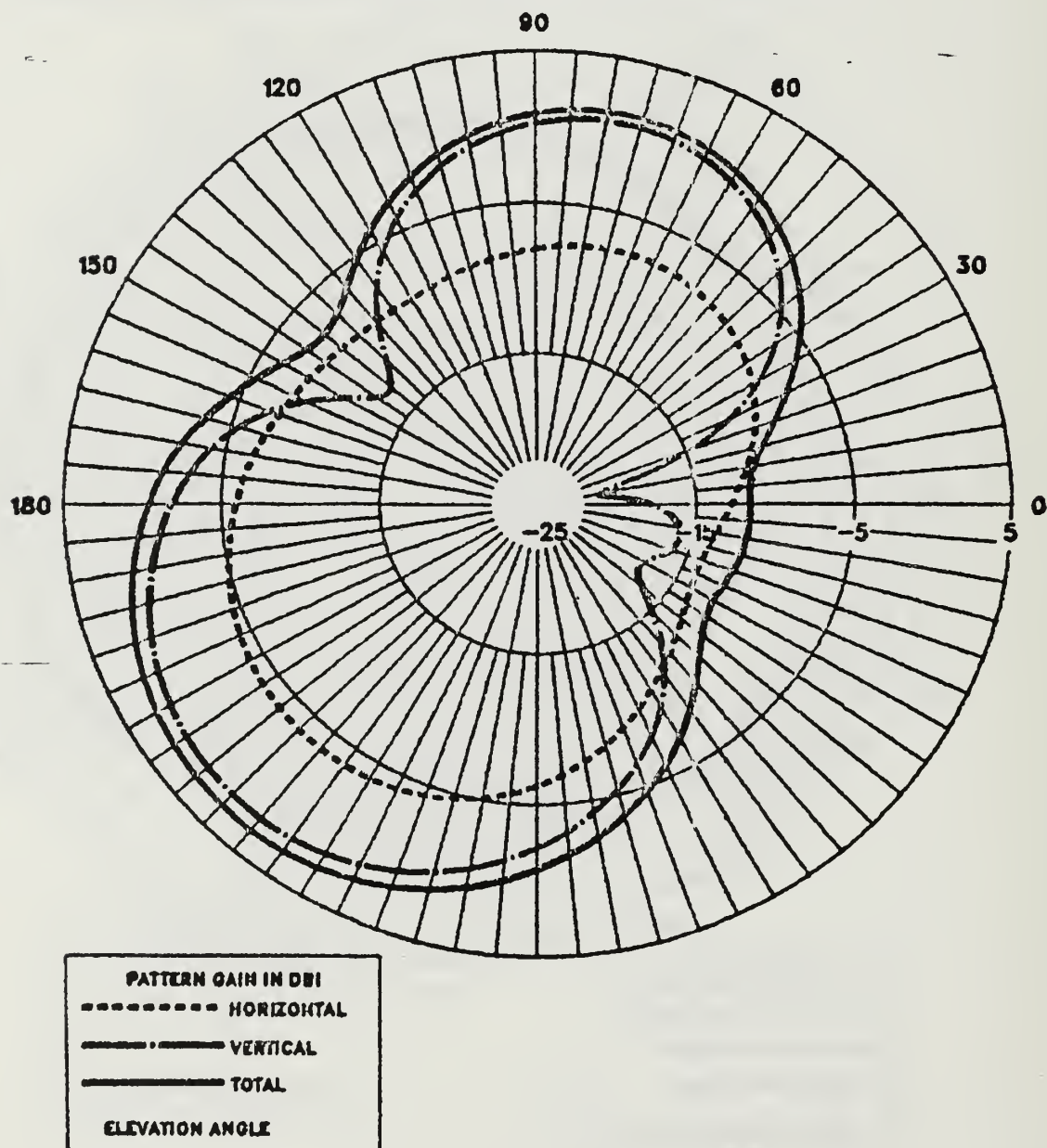
H65 IGUANA DATA RUN AT 13.974MHZ ON 8/25/87

LONG-WIRE ANT, FREE SPACE, HORIZ CUT, THETA=26



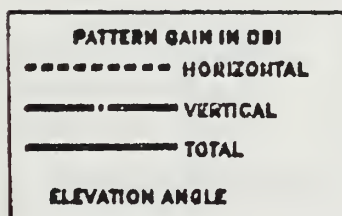
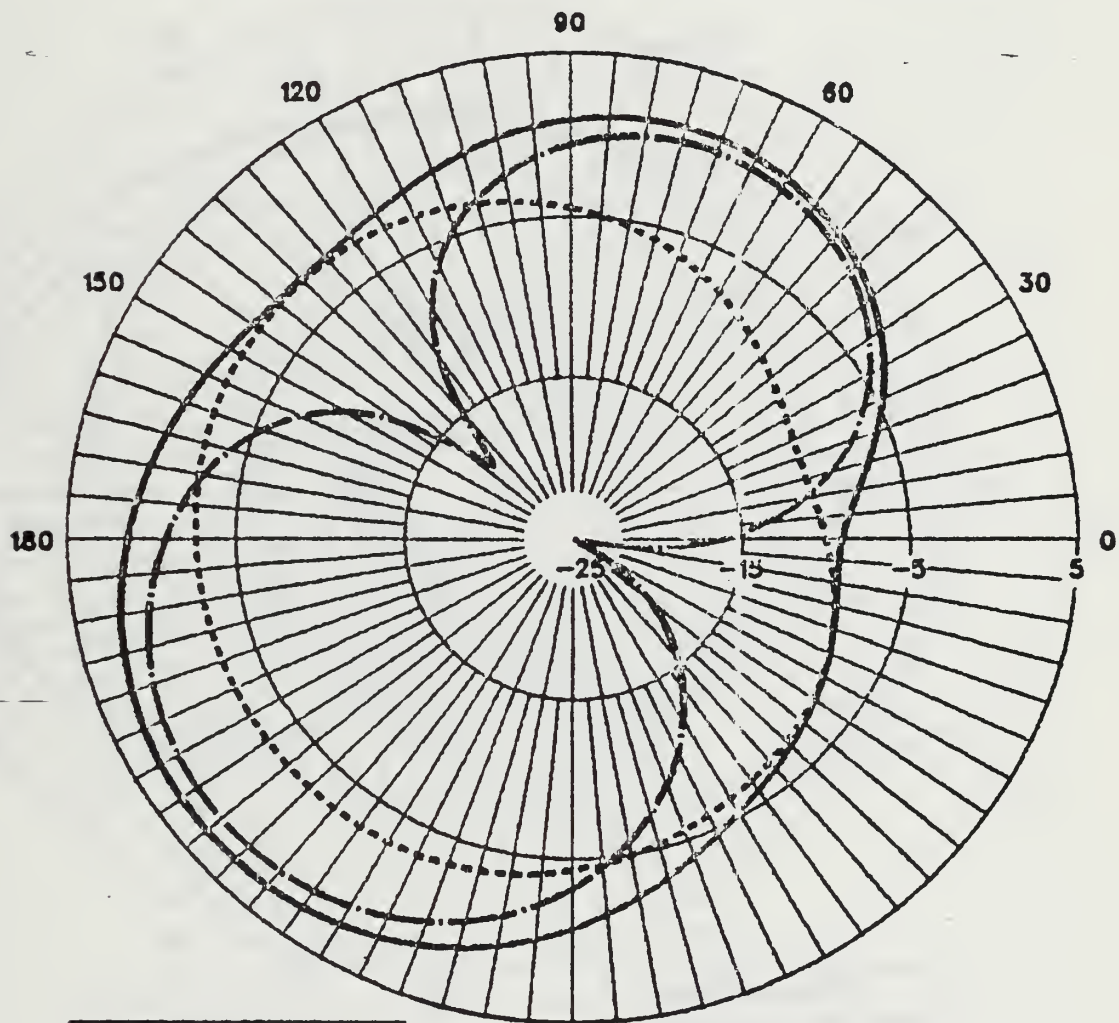
H65 IGUANA DATA RUN AT 13.974MHZ ON 8/25/87

LONG-WIRE ANT, FREE SPACE, VERT CUT, PHI=0



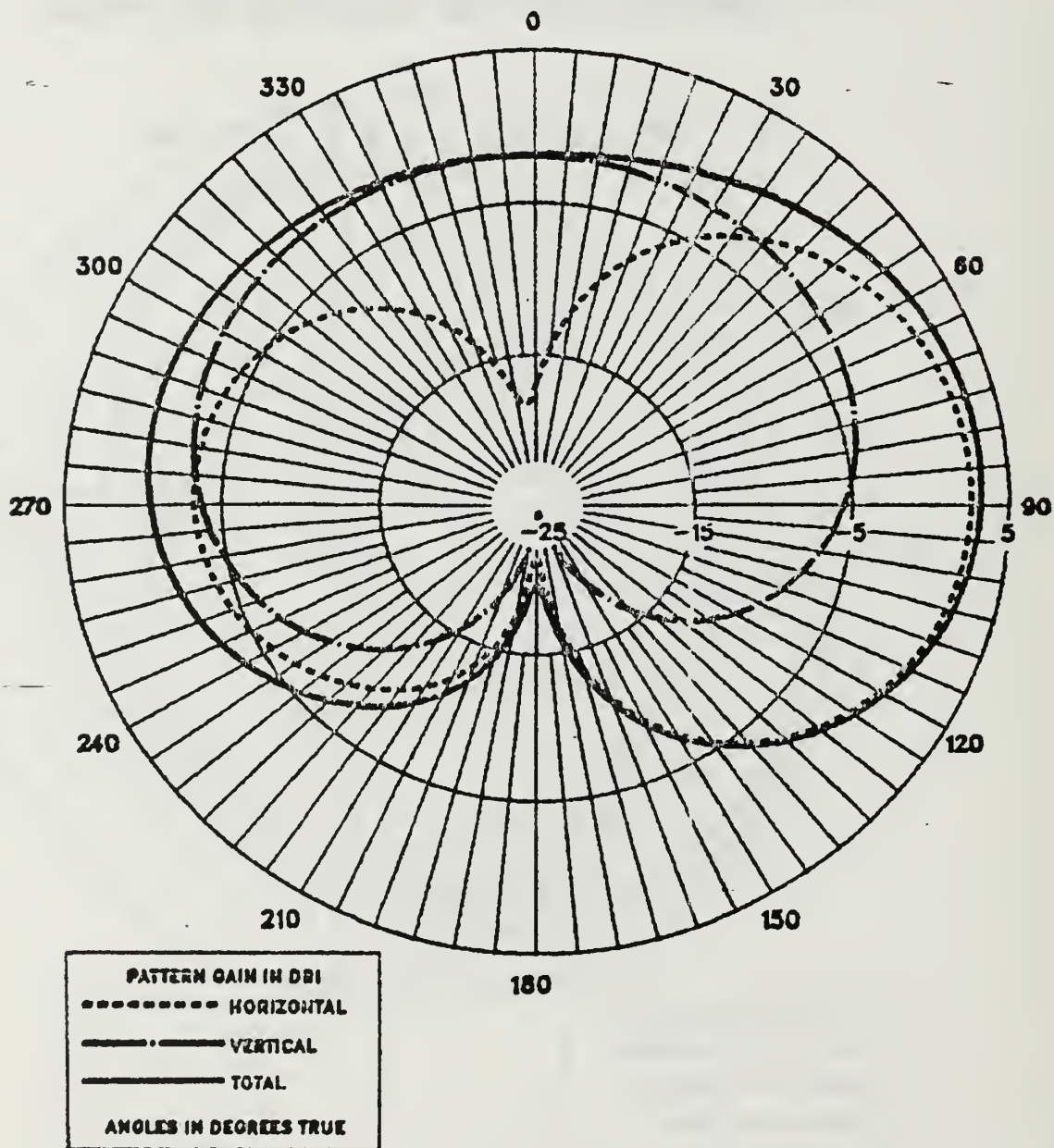
H65 IGUANA DATA RUN AT 13.974MHZ ON 8/25/87

LONG-WIRE ANT, FREE SPACE, VERT CUT, PHI=45



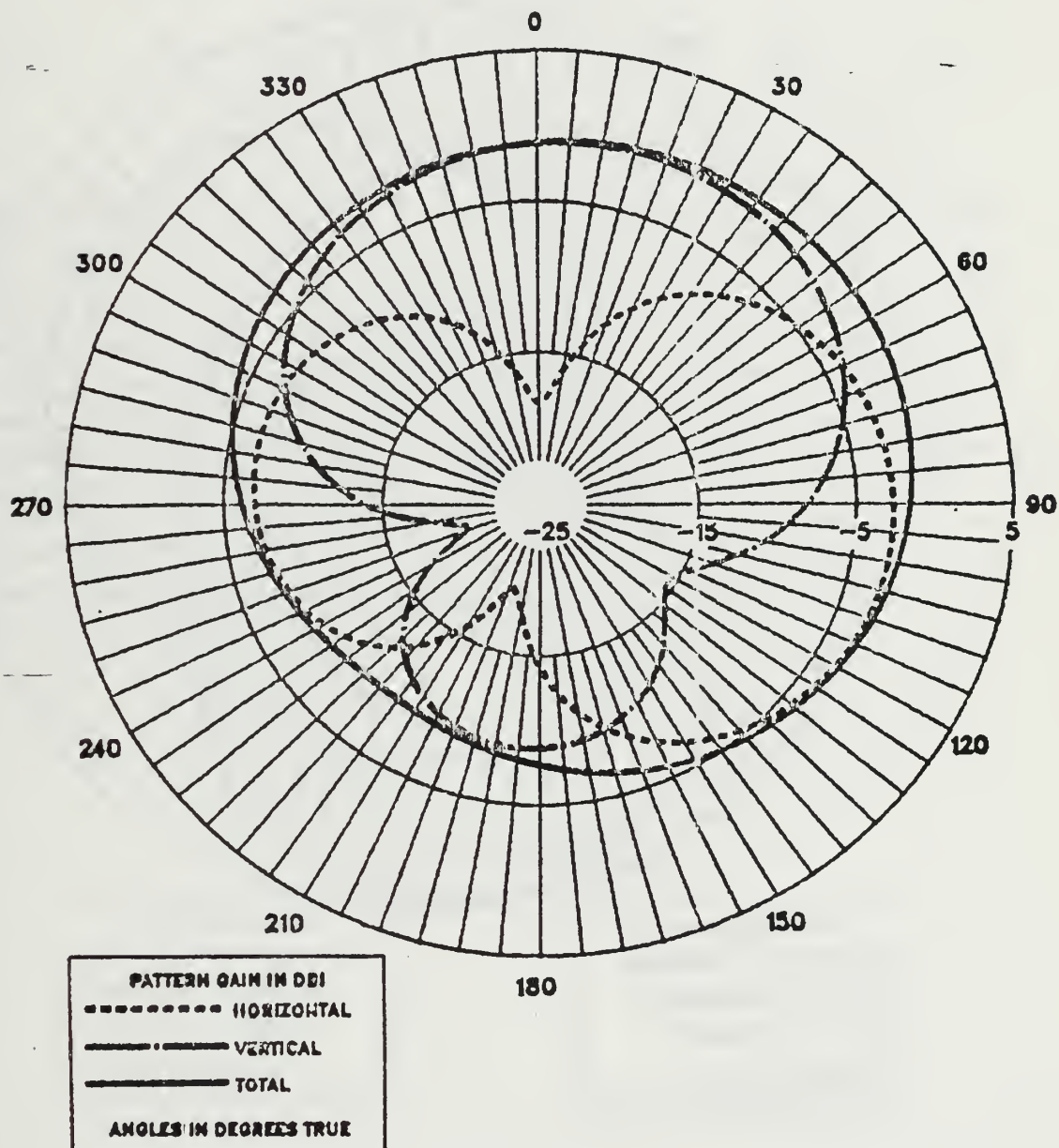
H65 IGUANA DATA RUN AT 13.974MHZ ON 8/25/87

COLLINS 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=90



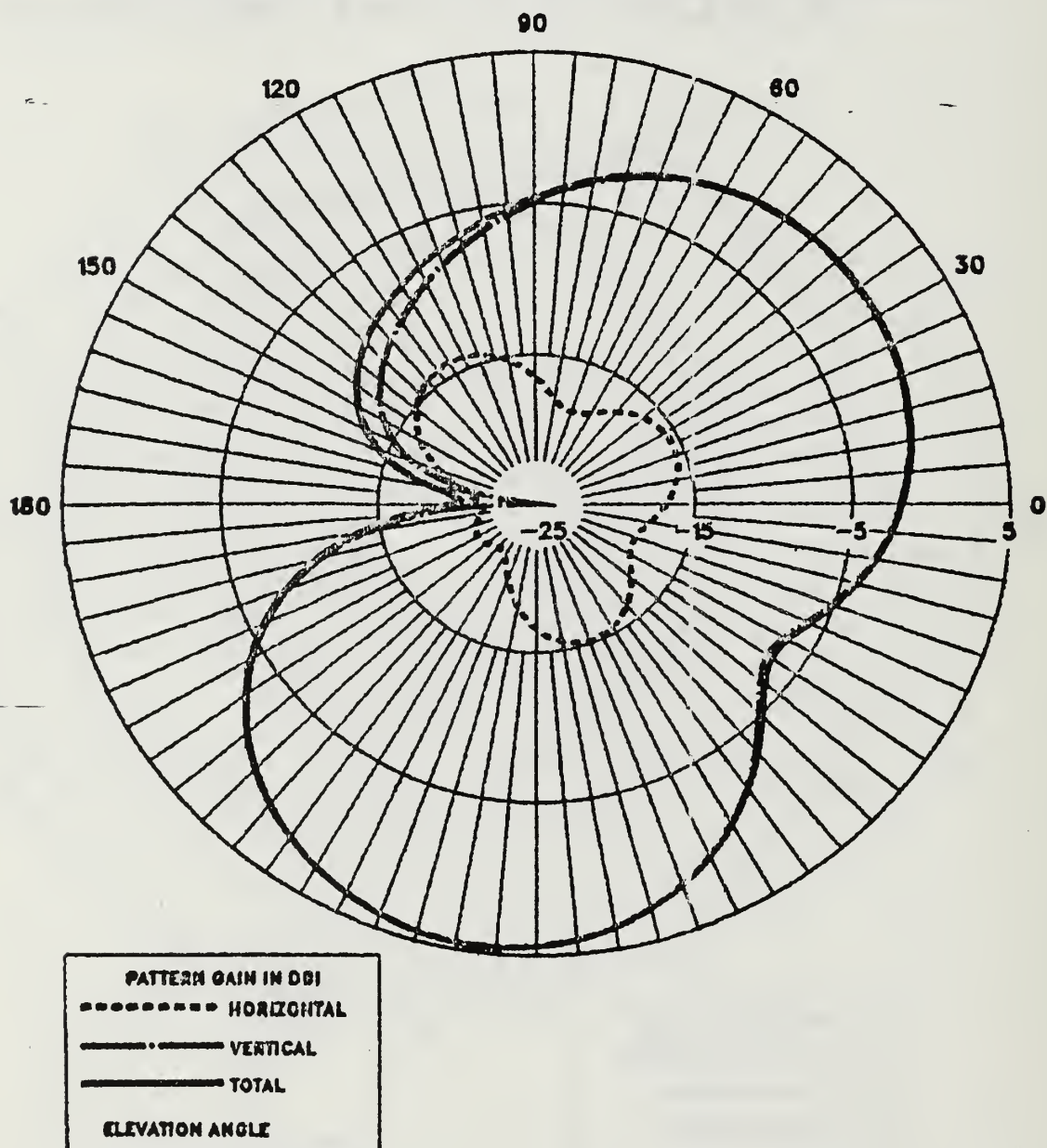
H65 IGUANA DATA RUN AT 13.974MHZ ON 8/25/87

COLLINS 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=26



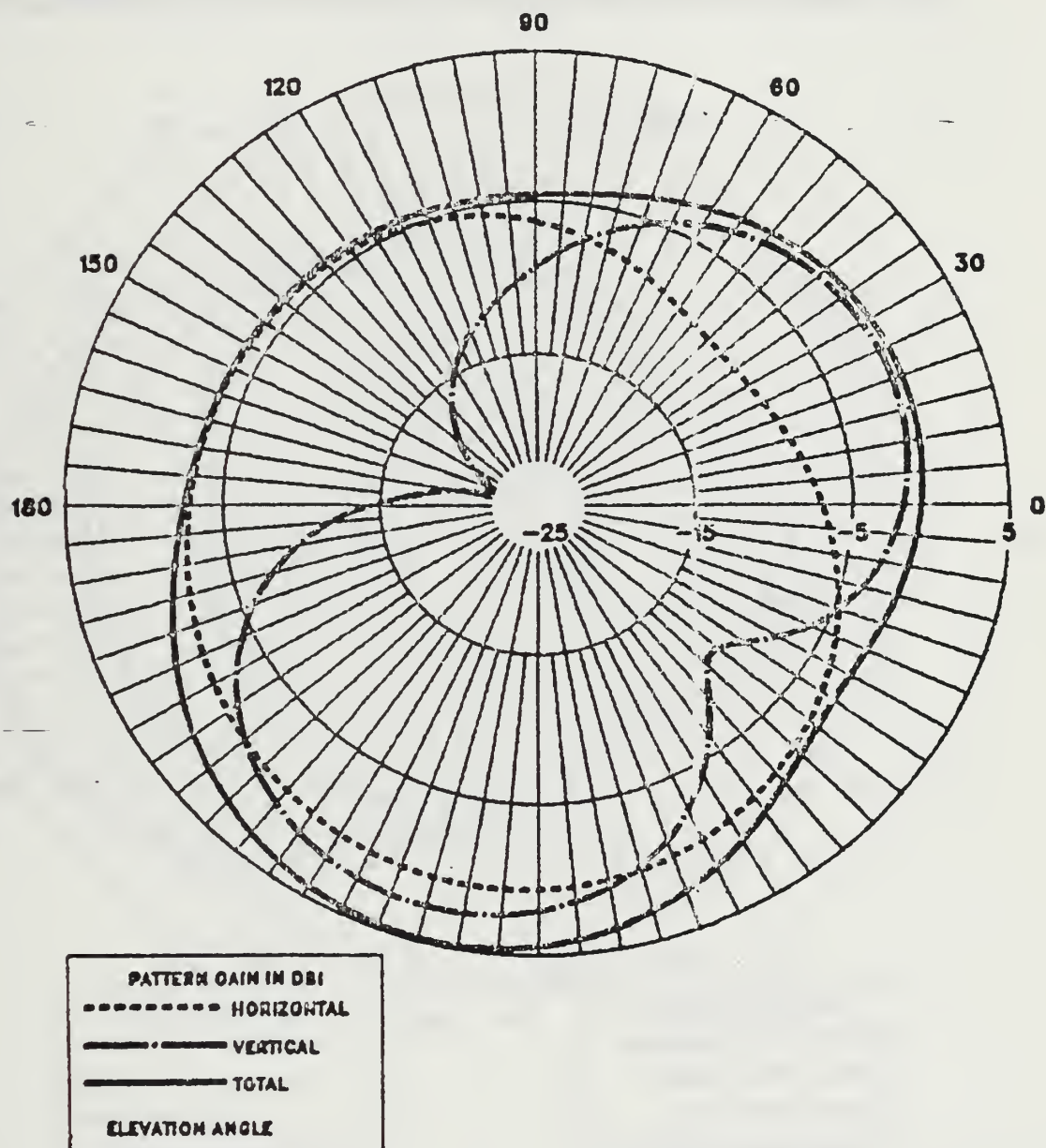
H65 IGUANA DATA RUN AT 13.974MHZ ON 8/25/87

COLLINS 437R-2 ANT, FREE SPACE, VERT CUT, PHI=0



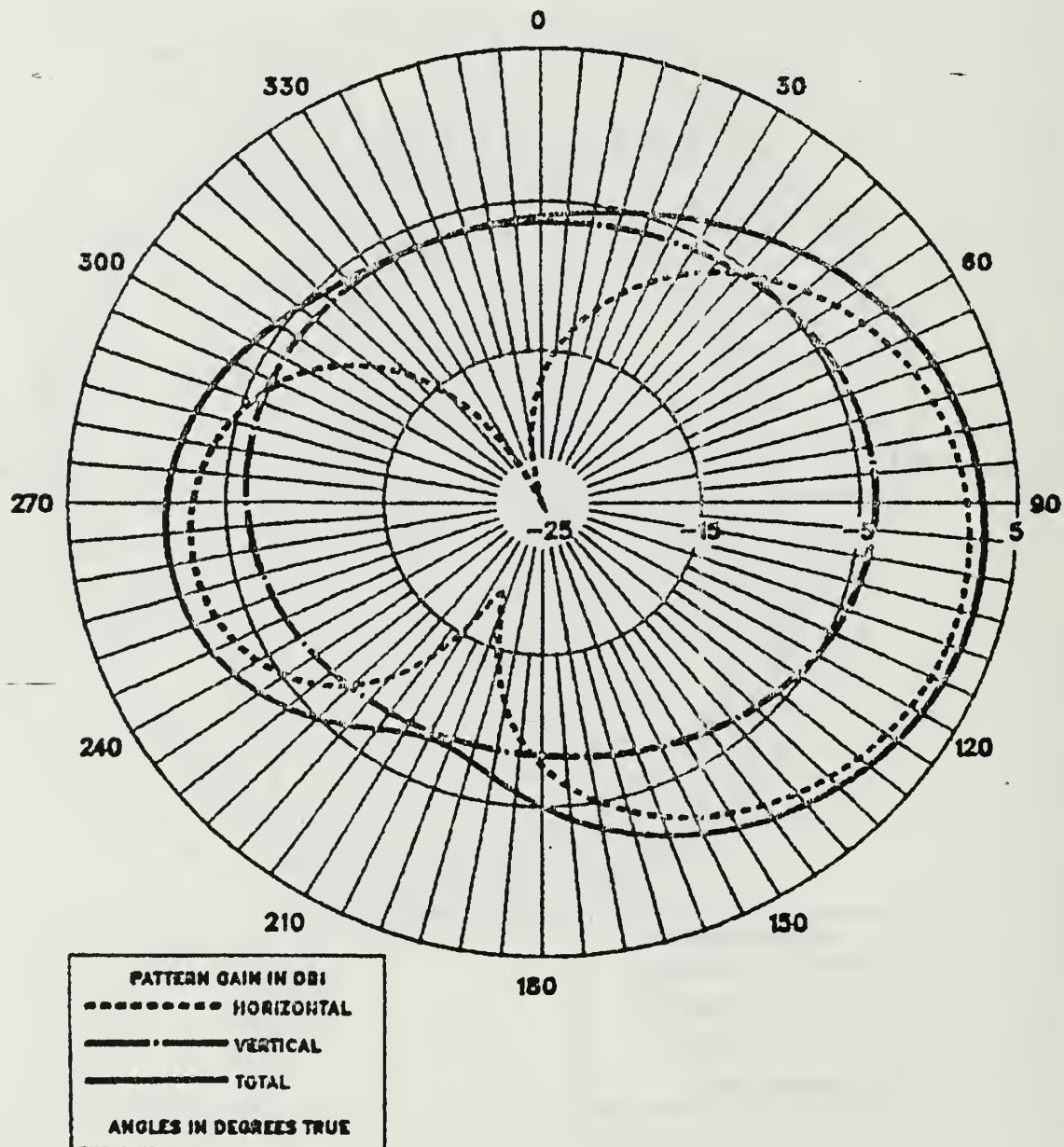
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COLLINS 437R-2 ANT, FREE SPACE, VERT CUT, PHI=45



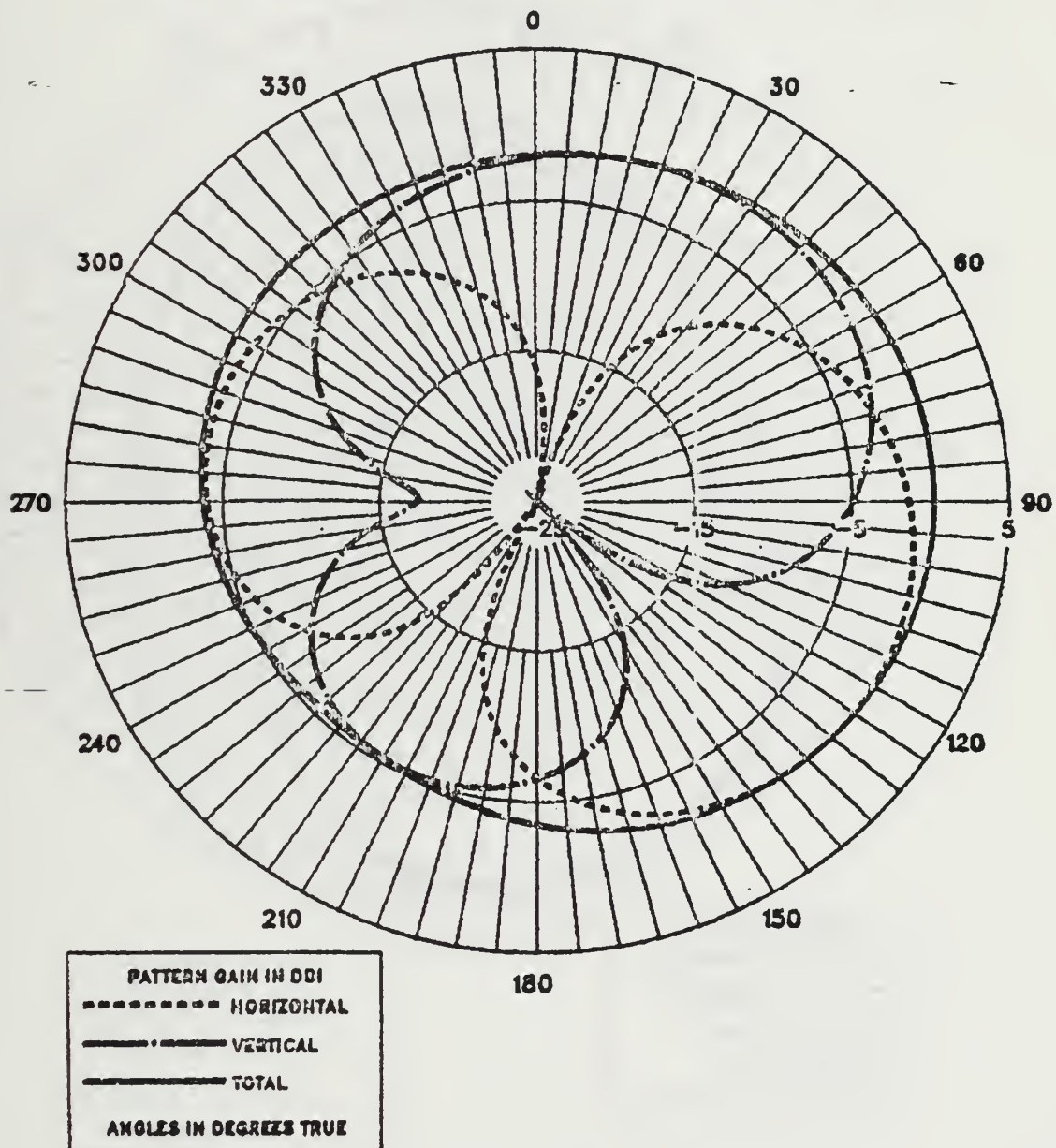
H65 IGUANA DATA RUN AT 13.974MHZ ON 8/25/87

ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CUT, THETA=90



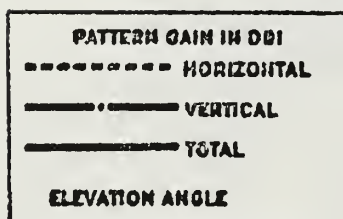
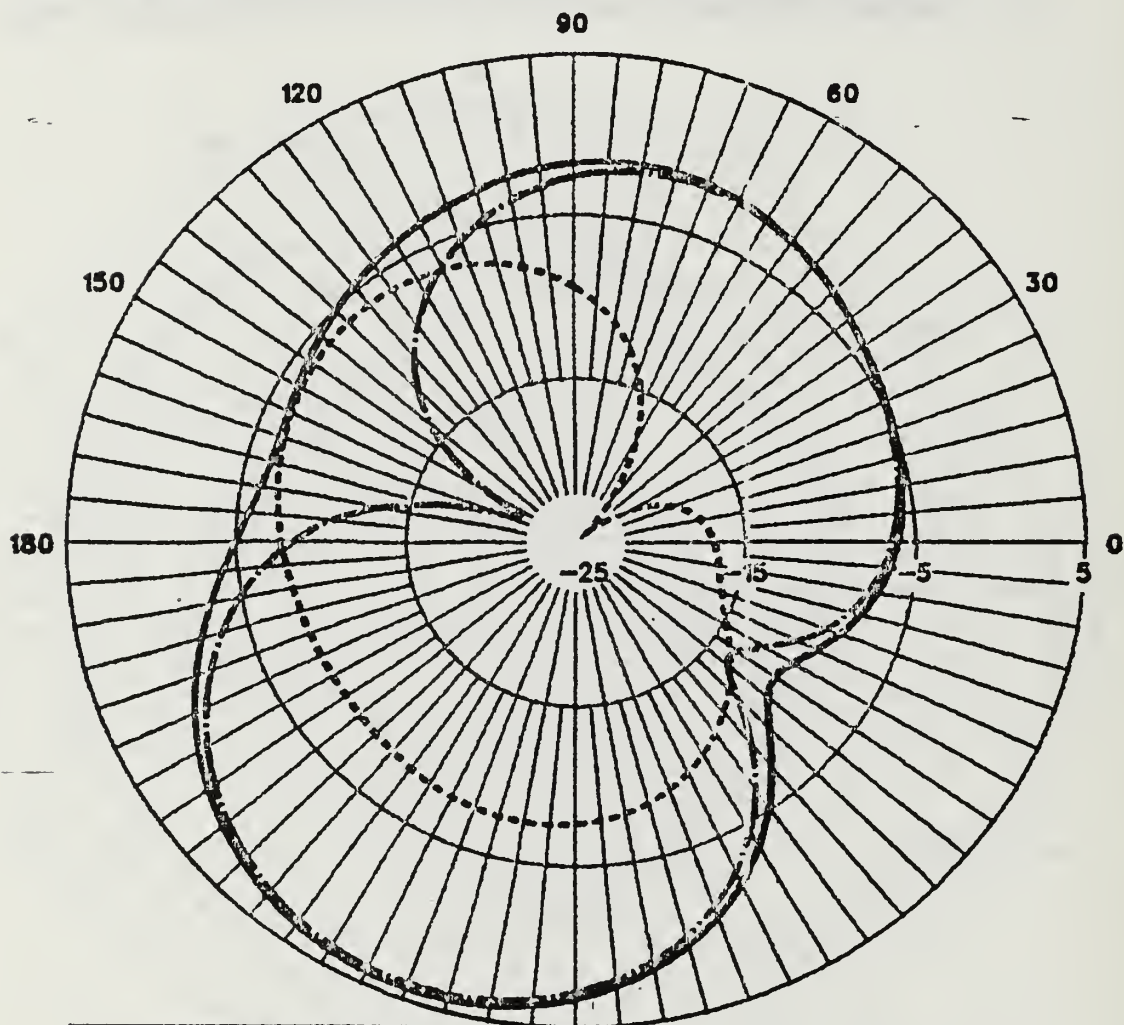
H65 IGUANA DATA RUN AT 13.974MHZ ON 8/25/87

ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CUT, THETA=26



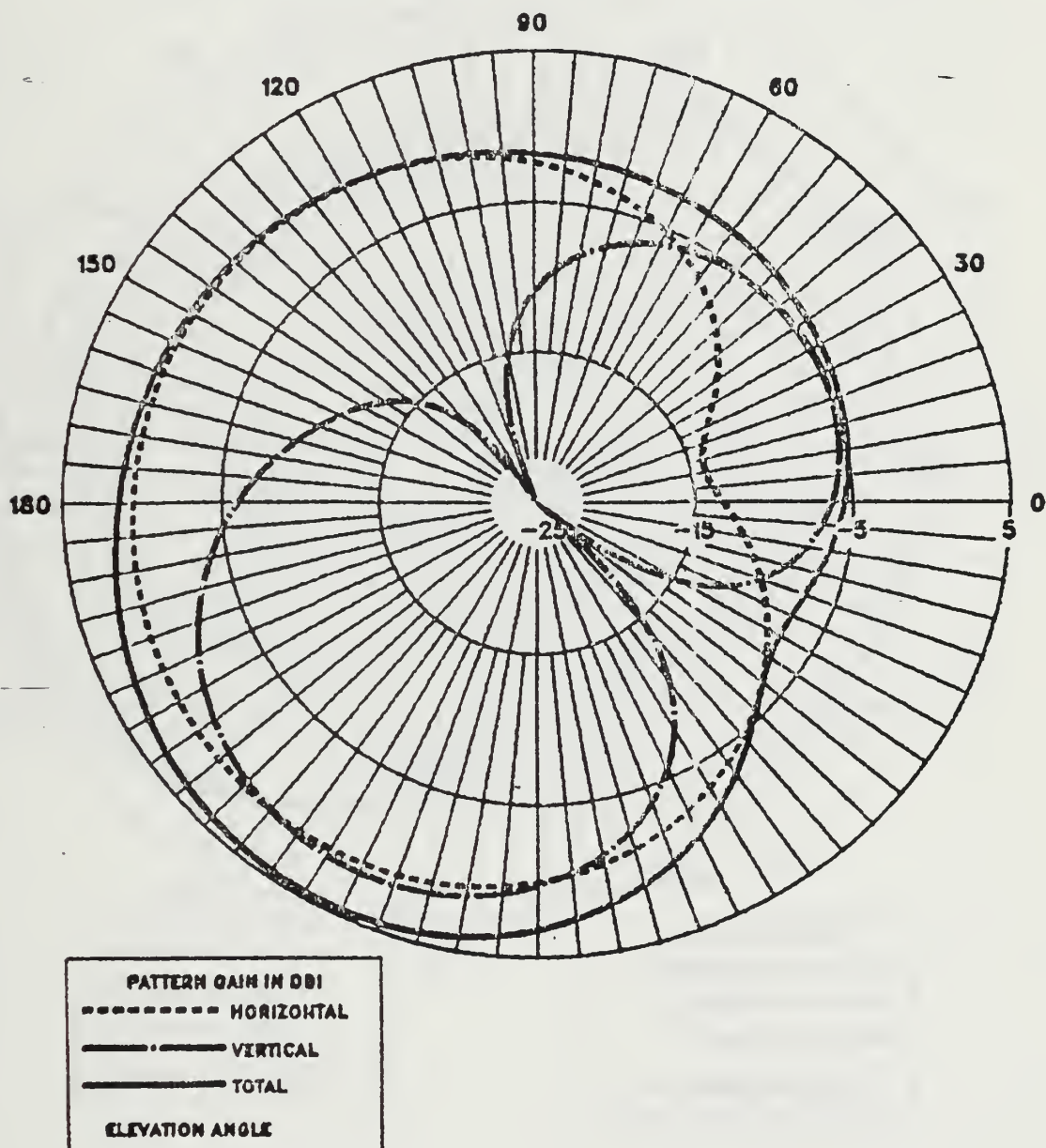
H65 IGUANA DATA RUN AT 13.974MHZ ON 8/25/87

ARMY-TYPE TUBE ANT, FREE SPACE, VERT CUT, PHI=0



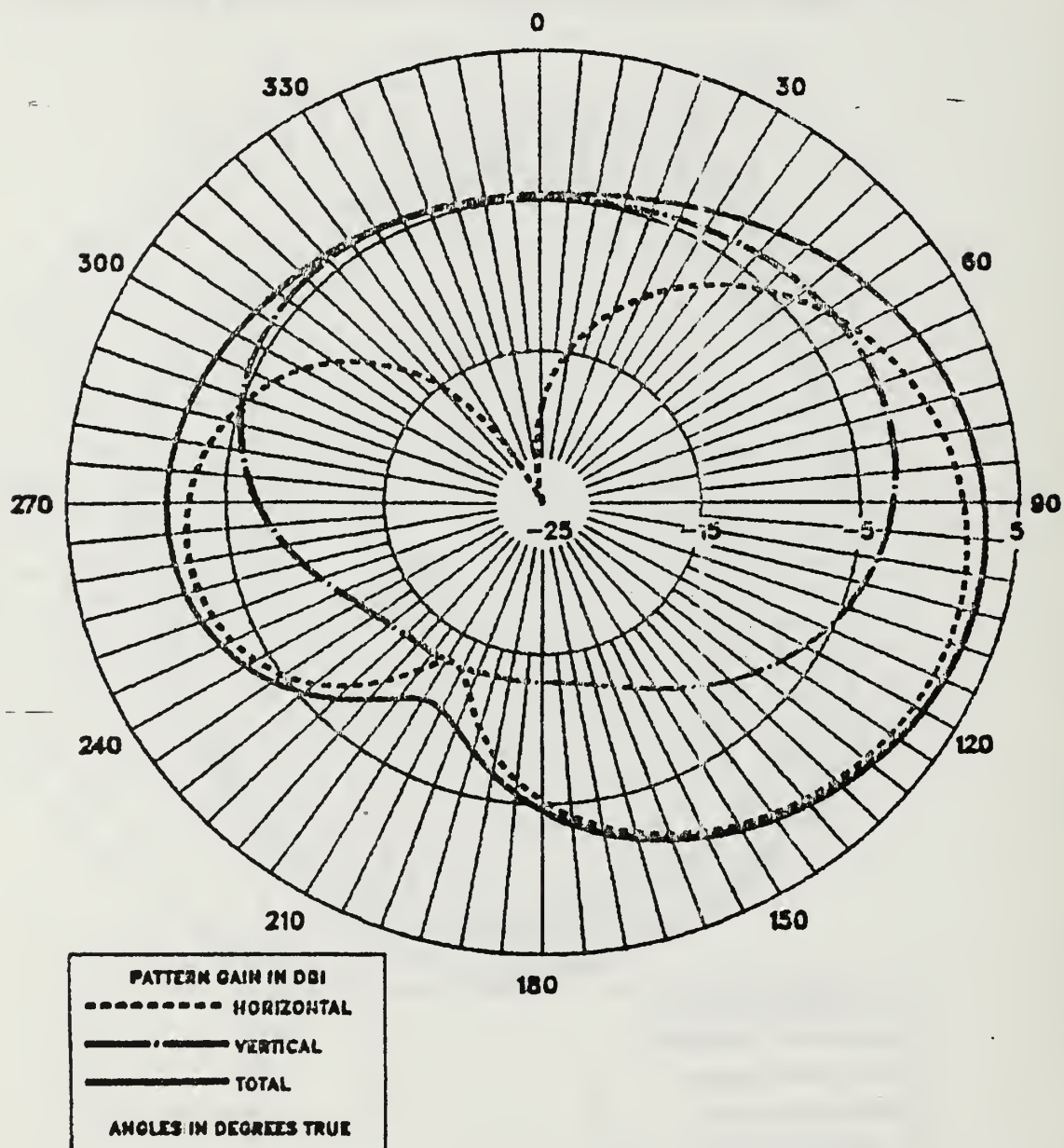
H65 IGUANA DATA RUN AT 13.974MHZ ON 8/25/87

ARMY-TYPE TUGE ANT, FREE SPACE, VERT CUT, PHI=45



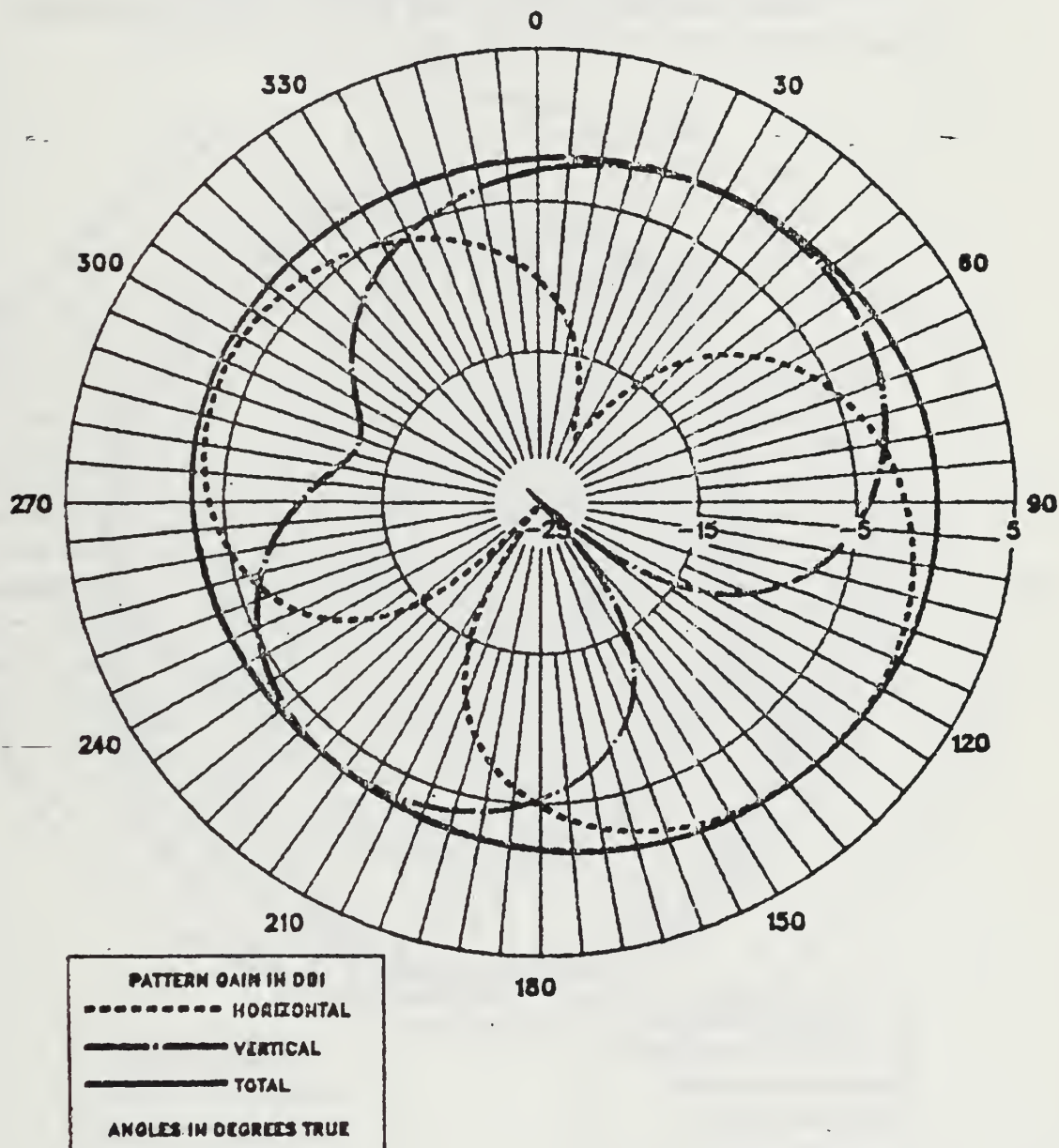
H65 IGUANA DATA RUN AT 13.974MHZ ON 8/25/87

LONG SHUNTED LOOP, FREE SPACE, HORIZ CUT, THETA=90



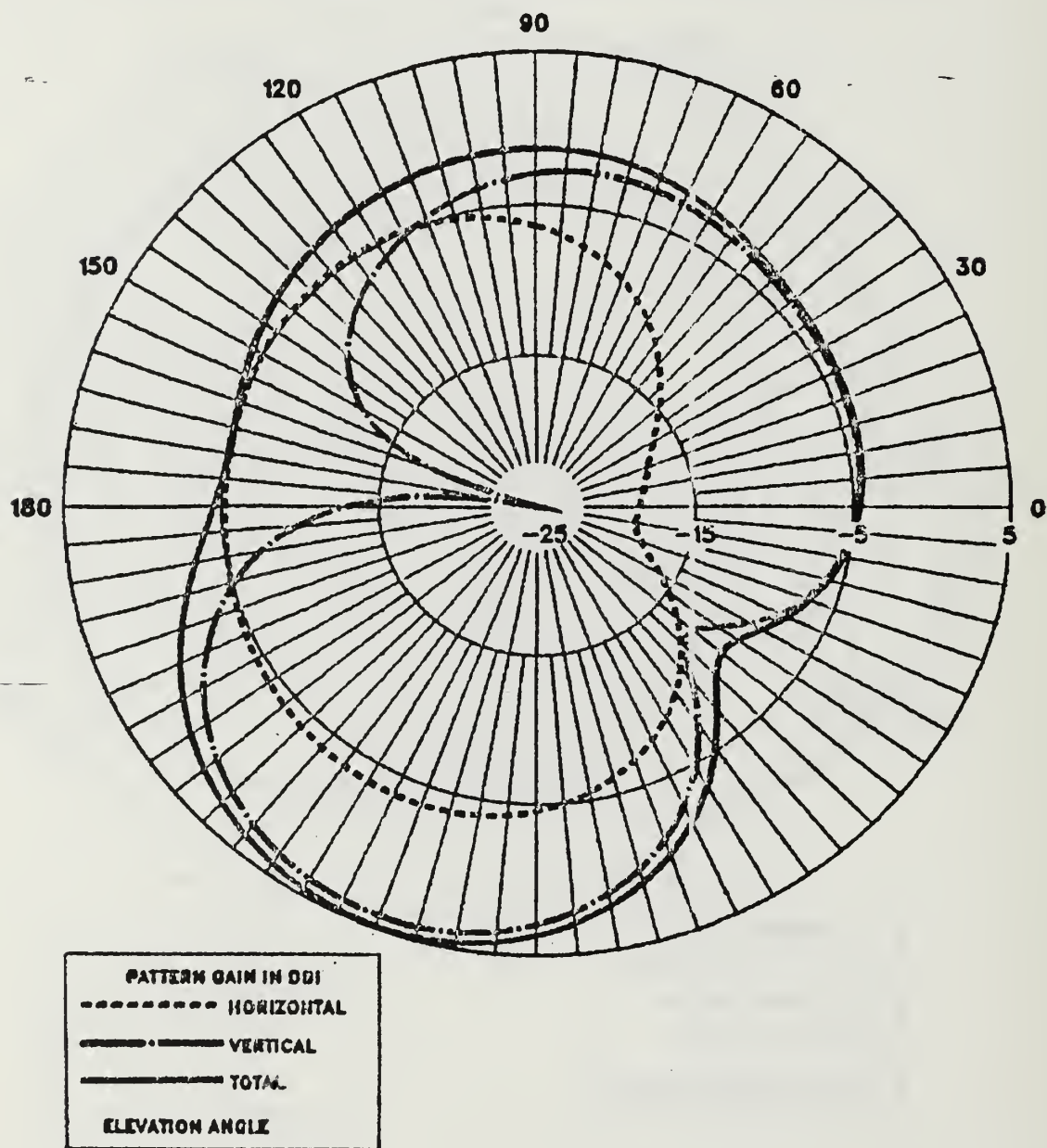
H65 IGUANA DATA RUN AT 13.974MHZ ON 8/25/87

LONG SHUNTED LOOP, FREE SPACE, HORIZ CUT, THETA=26



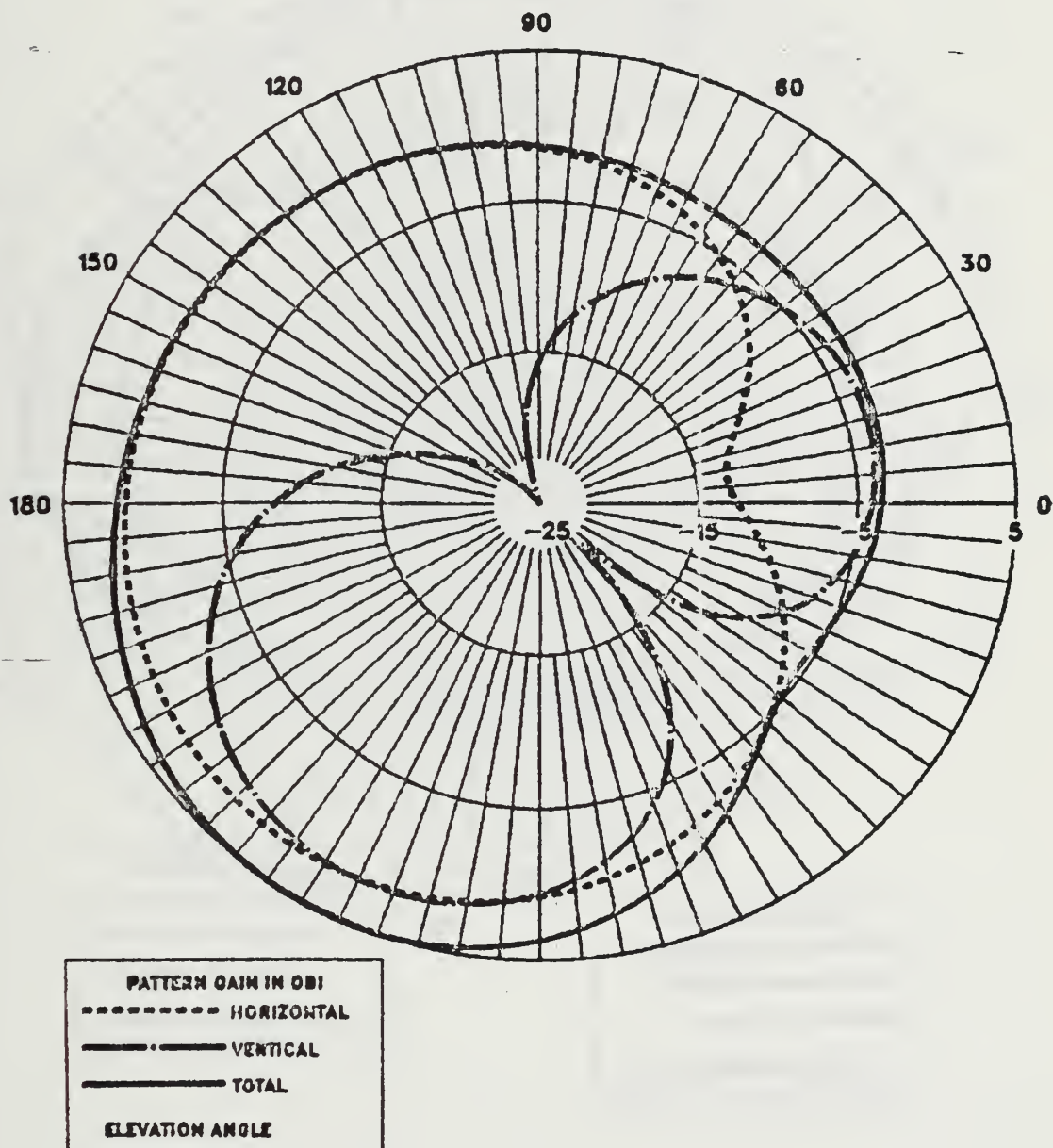
H65 IGUANA DATA RUN AT 13.974MHZ ON 8/25/87

LONG SHUNTED LOOP, FREE SPACE, VERT CUT, $\Phi=0$



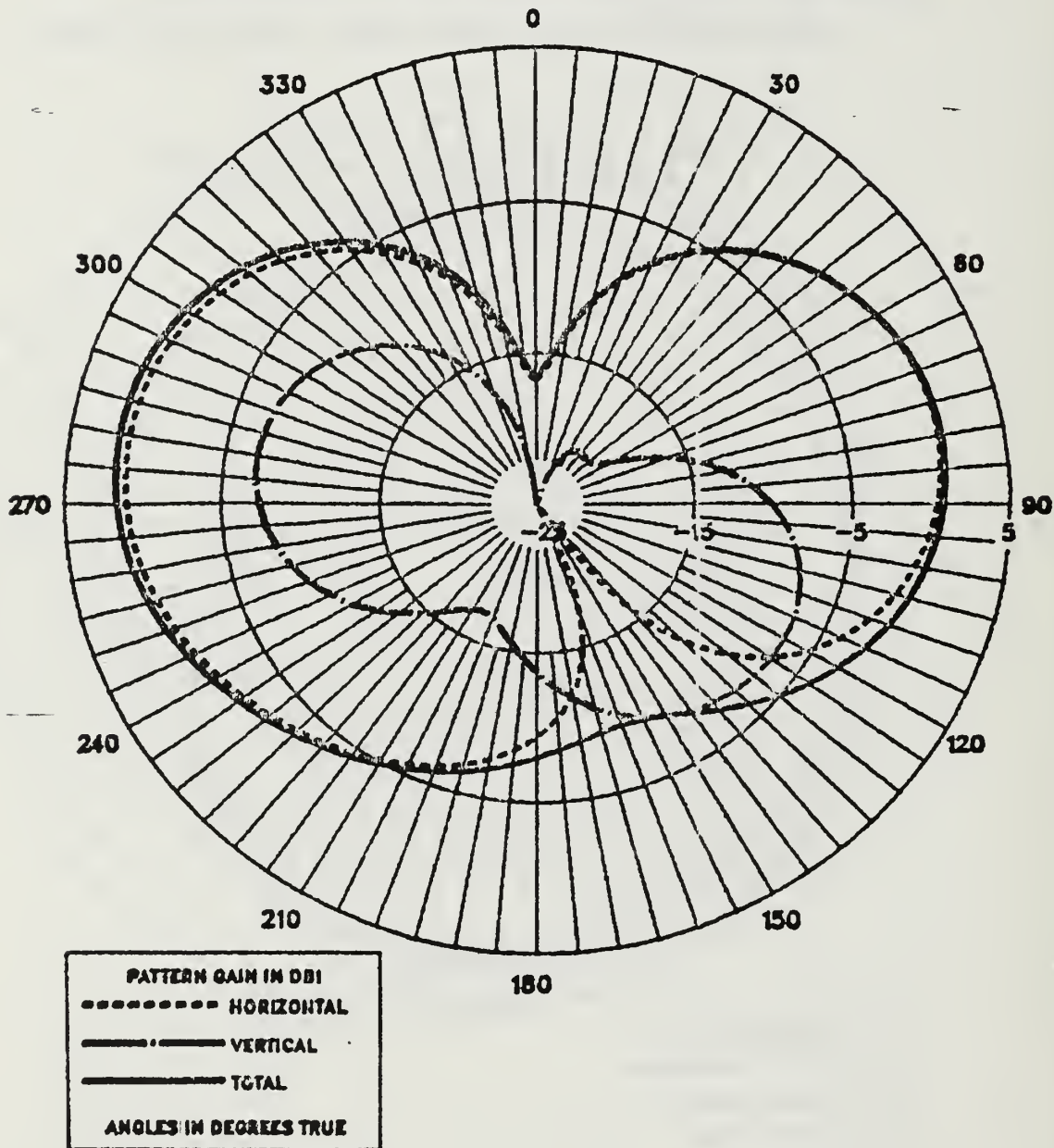
H65 IGUANA DATA RUN AT 13.974MHZ ON 8/25/87

LONG SHUNTED LOOP, FREE SPACE, VERT CUT, $\Phi=45$



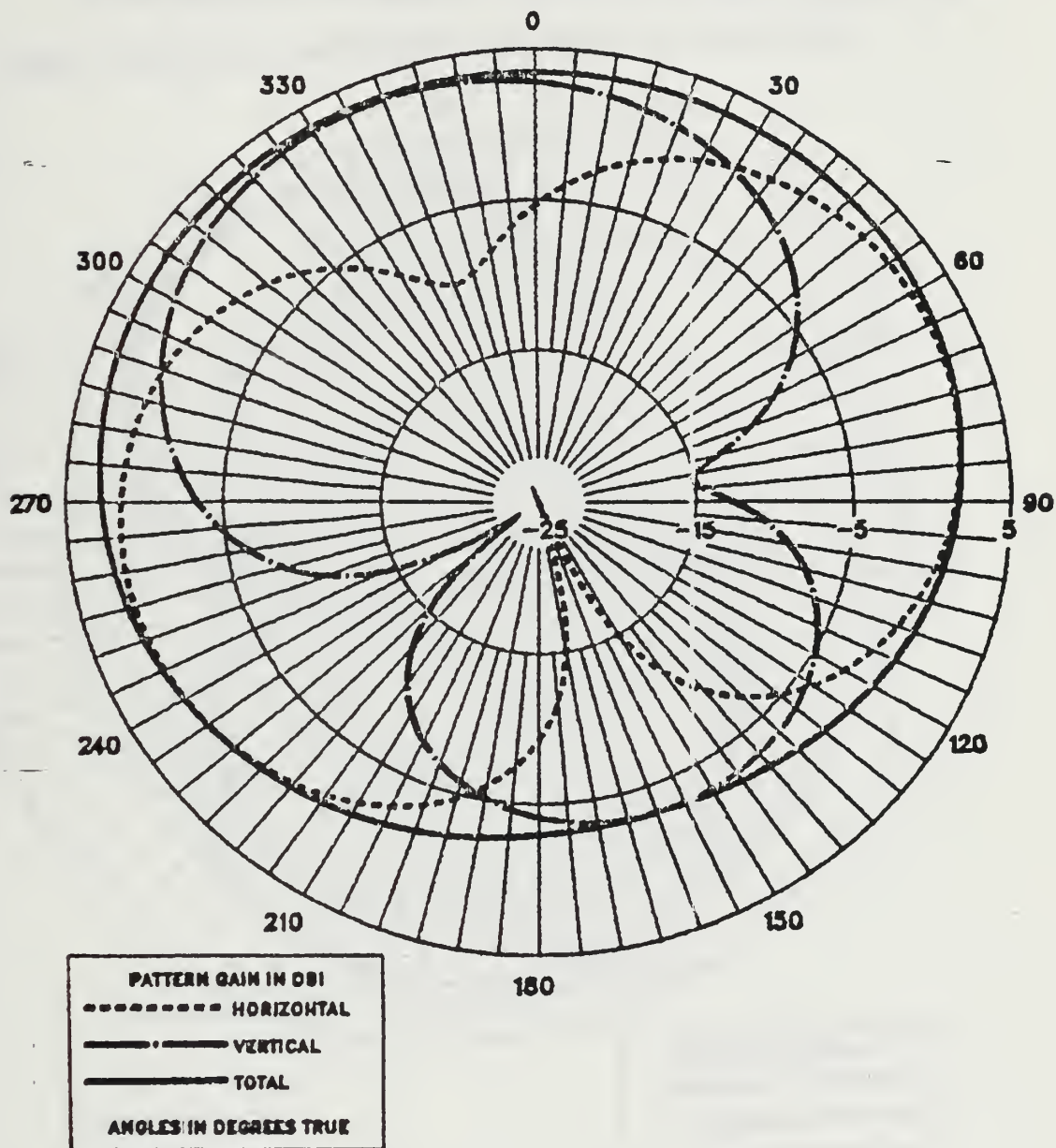
H65 IGUANA DATA RUN AT 18.1MHZ ON 8/18/87

LW SPACED 12" FROM A/C, FREE SPACE, HORIZ CUT, THETA=90



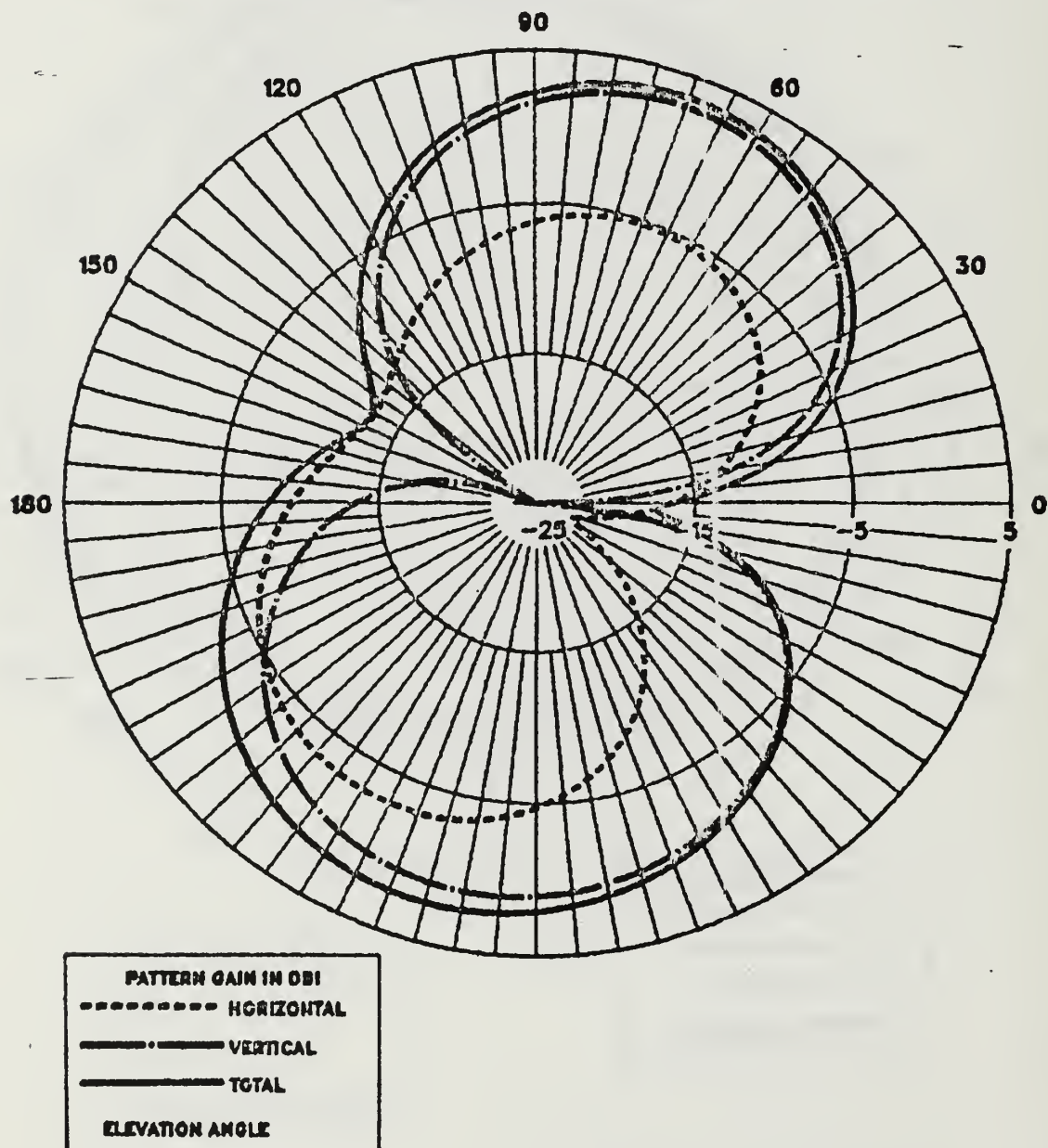
H65 IGUANA DATA RUN AT 18.1MHZ ON 8/18/87

LW SPACED 12" FROM A/C, FREE SPACE, HORIZ CUT, THETA=26



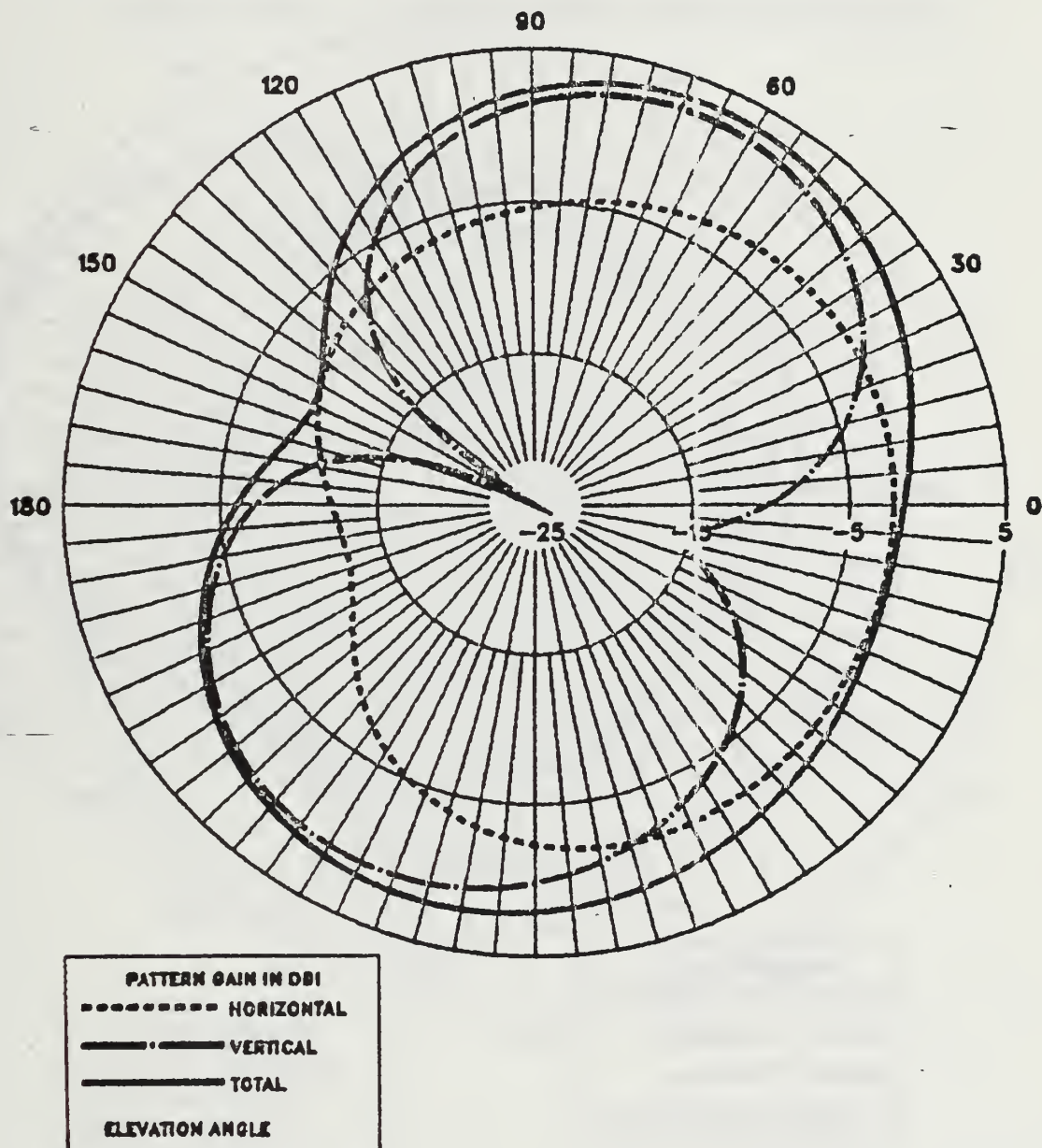
H65 IGUANA DATA RUN AT 18.1MHZ ON 8/18/87

LW SPACED 12" FROM A/C, FREE SPACE, VERT CUT, PHI=0



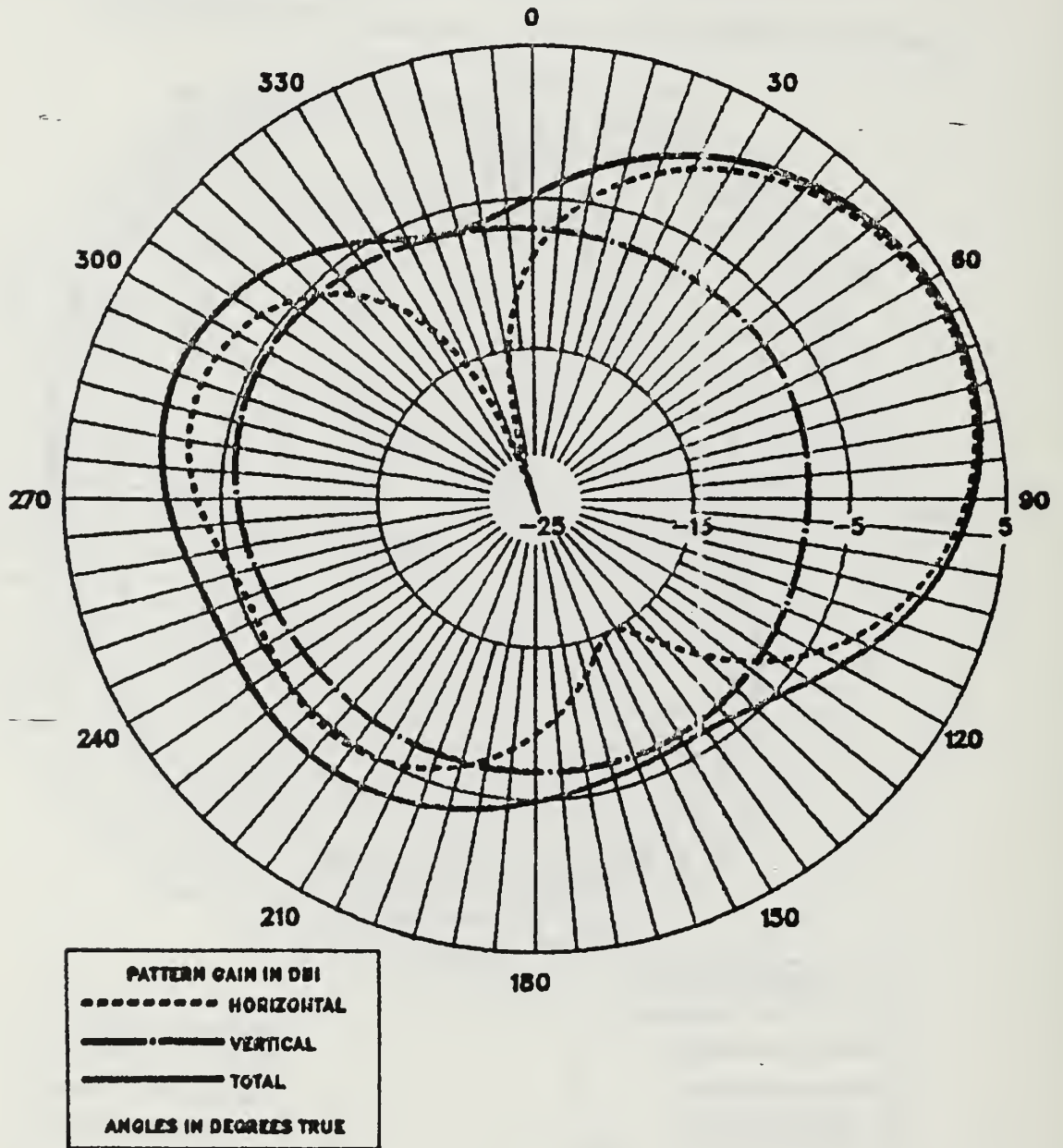
H65 IGUANA DATA RUN AT 18.1MHZ ON 8/18/87

LW SPACED 12" FROM A/C, FREE SPACE, VERT CUT, PHI=45



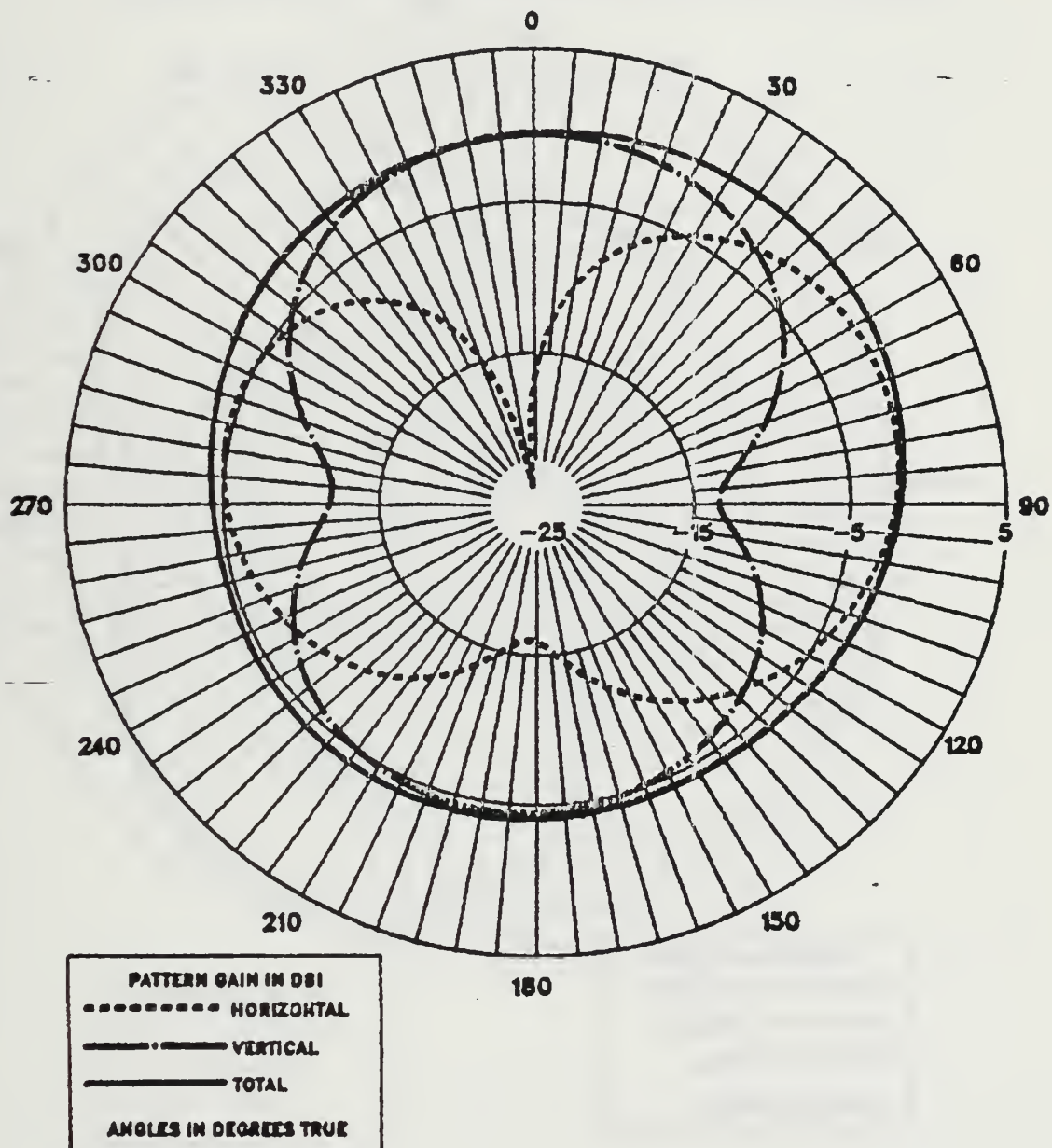
H65 IGUANA DATA RUN AT 18.1MHZ ON 8/15/87

COLLINS 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=90



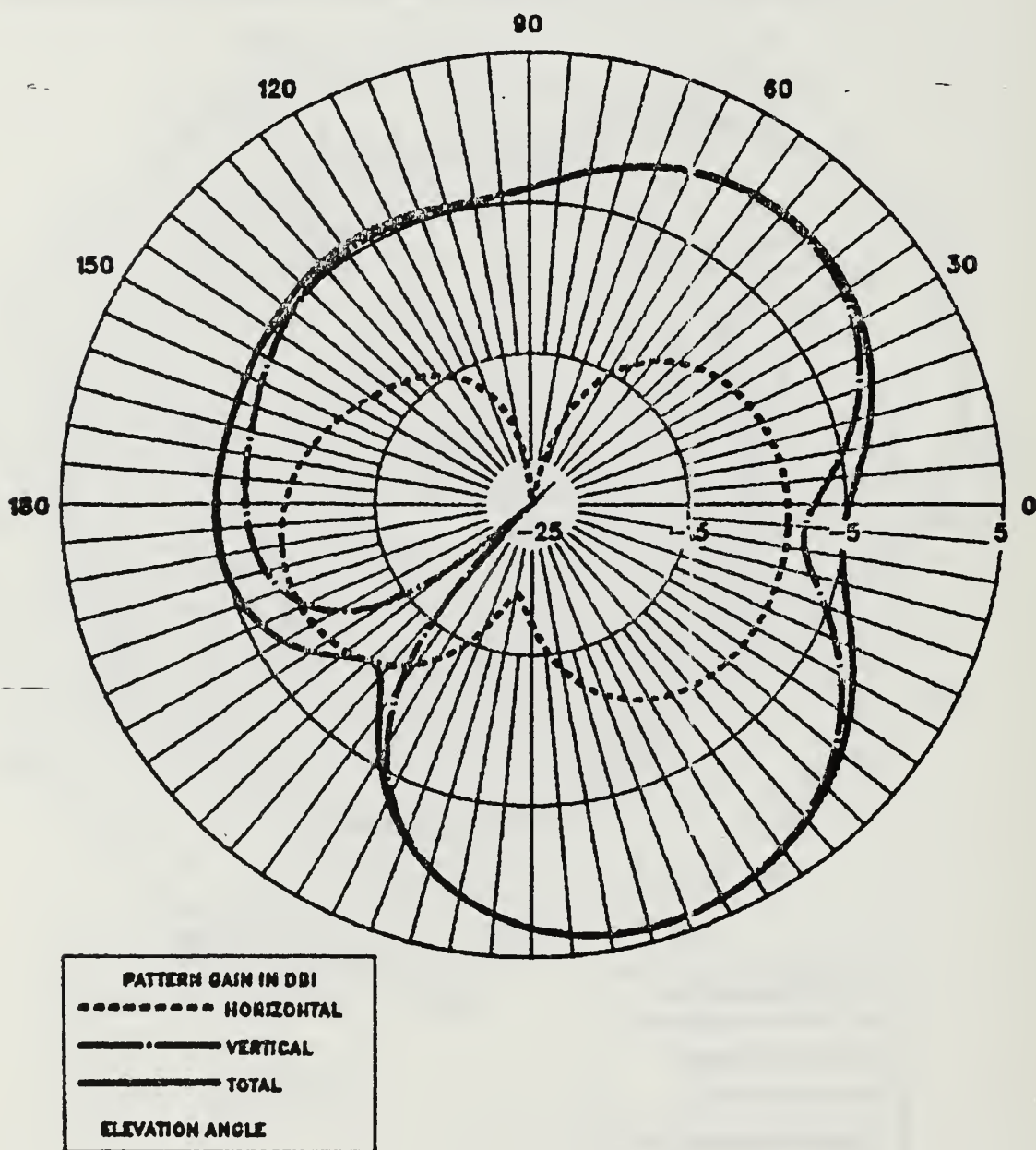
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COLLINS 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=26



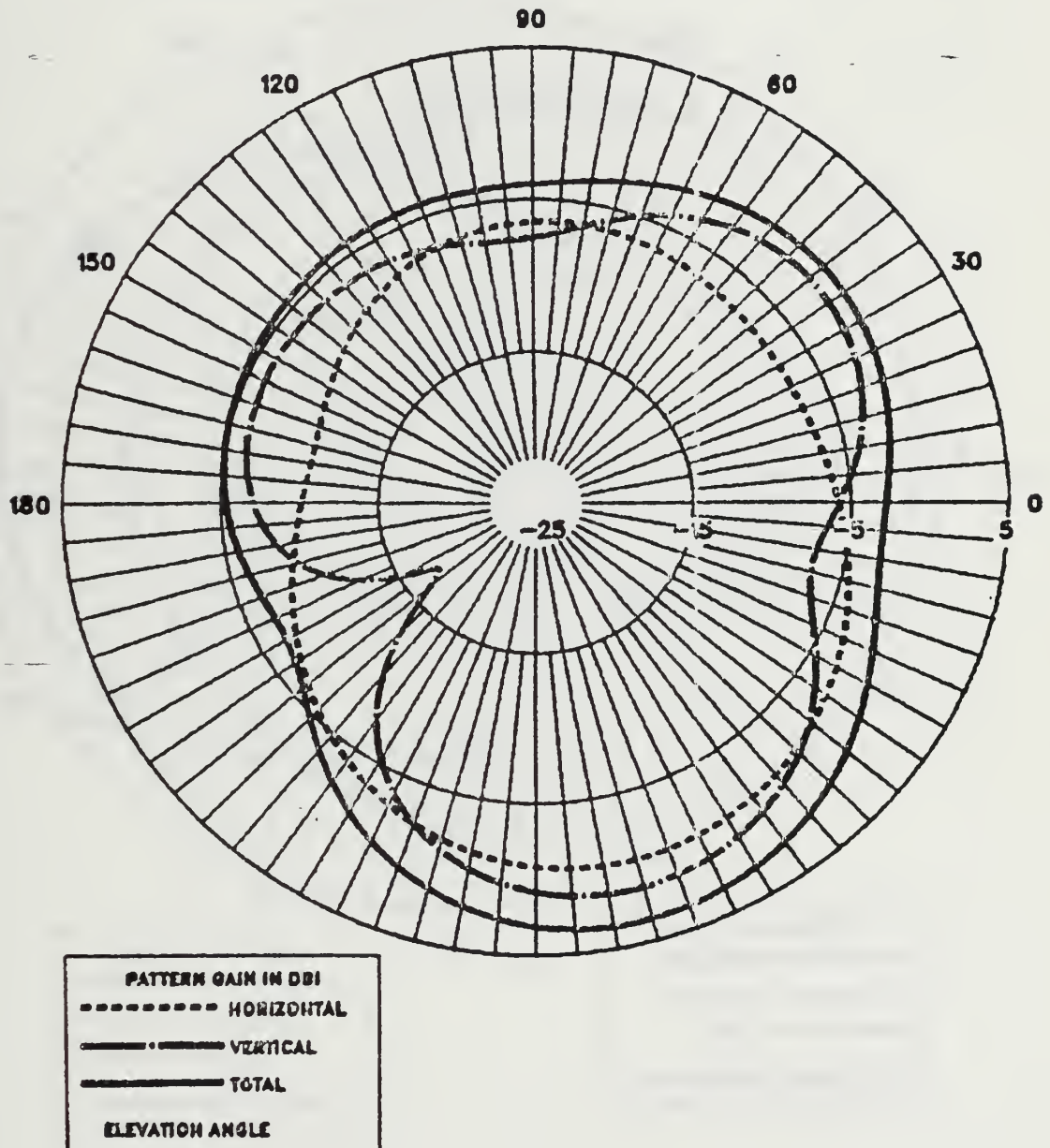
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COLLINS 437R-2 ANT, FREE SPACE, VERT CUT, PHI=0



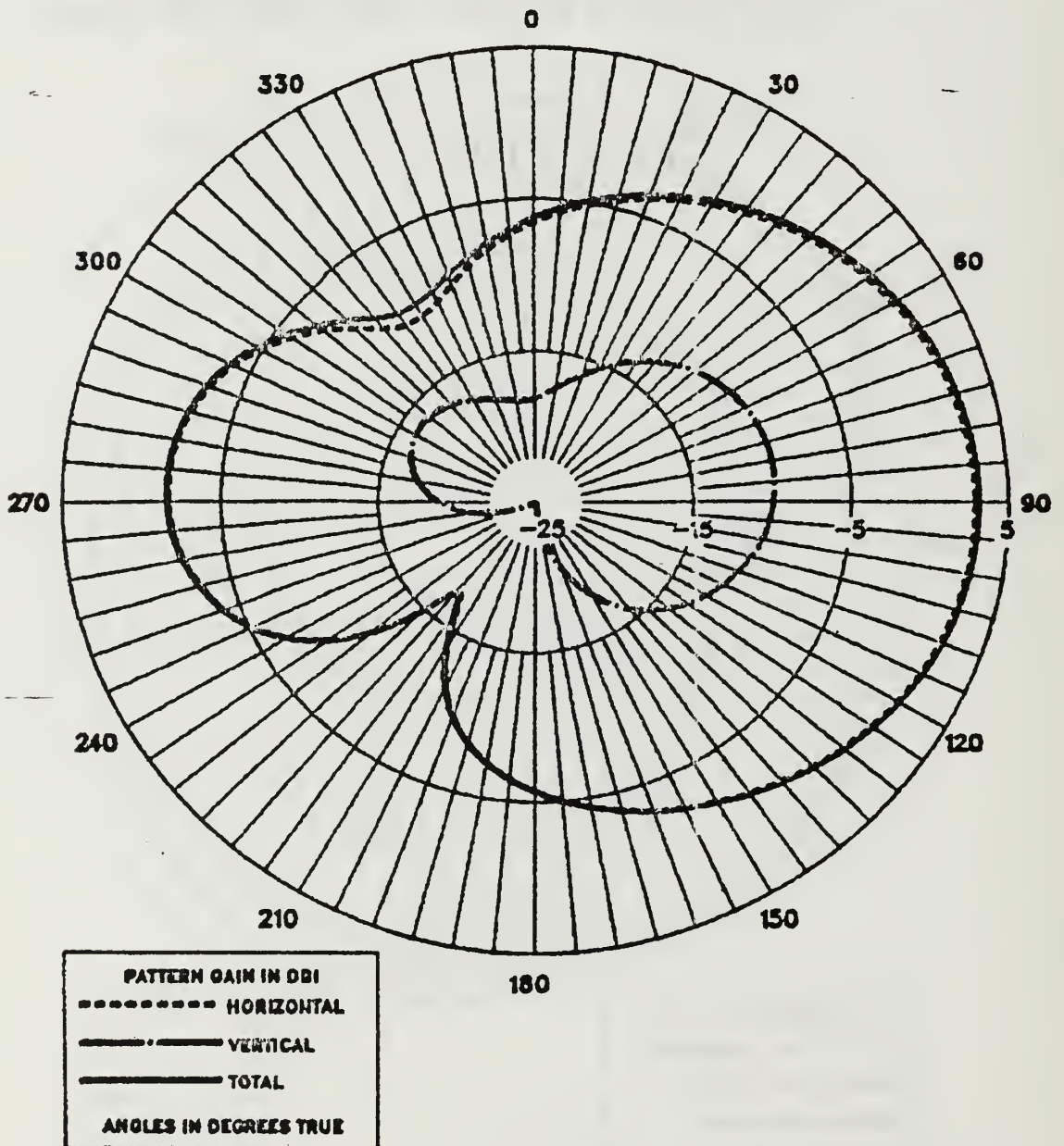
H65 IGUANA DATA RUN AT 18.1MHZ ON 8/15/87

COLLINS 437R-2 ANT, FREE SPACE, VERT CUT, $\Phi=45$



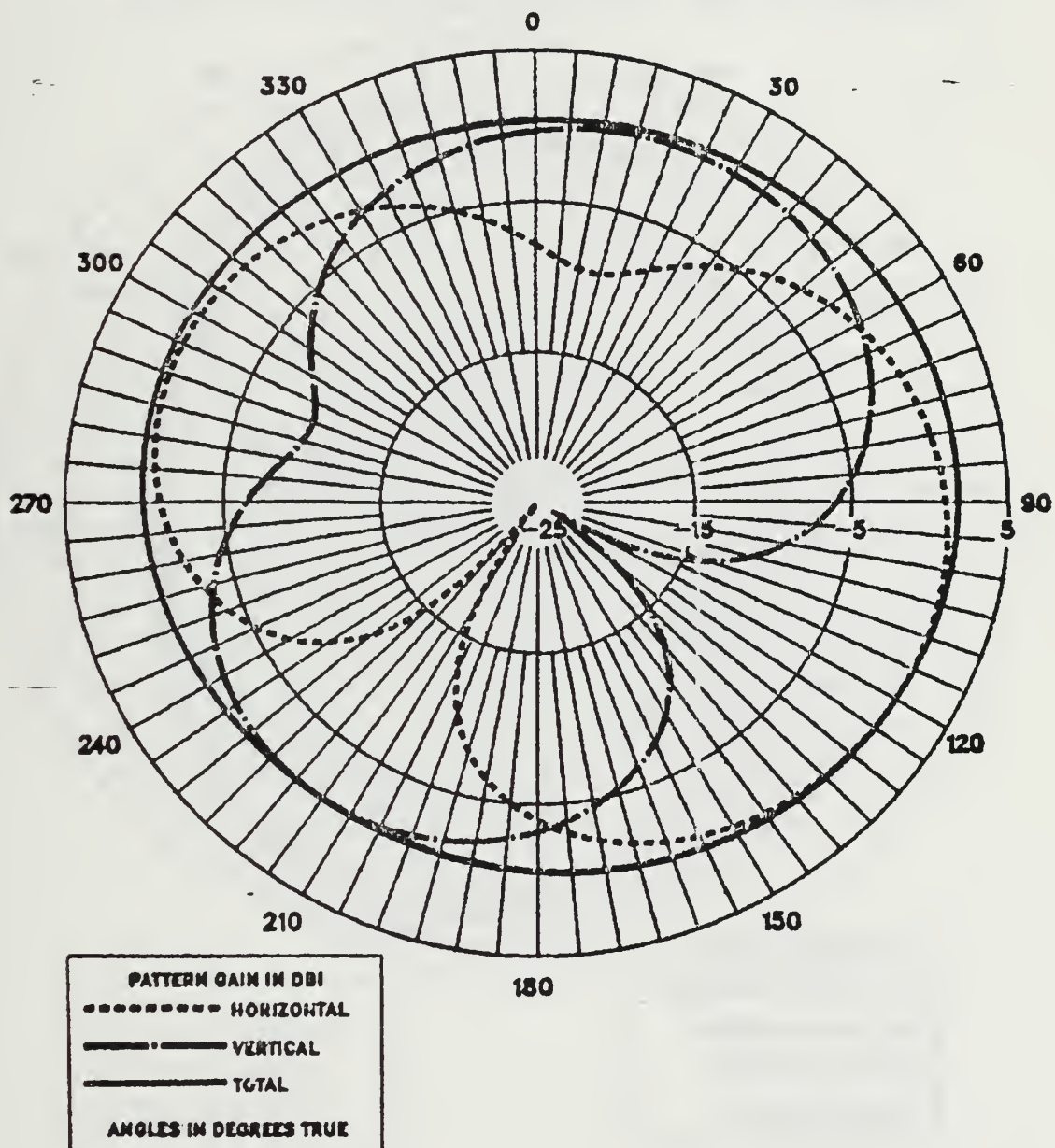
H65 IGUANA DATA RUN AT 18.1MHZ ON 8/15/87

ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CUT, THETA=90



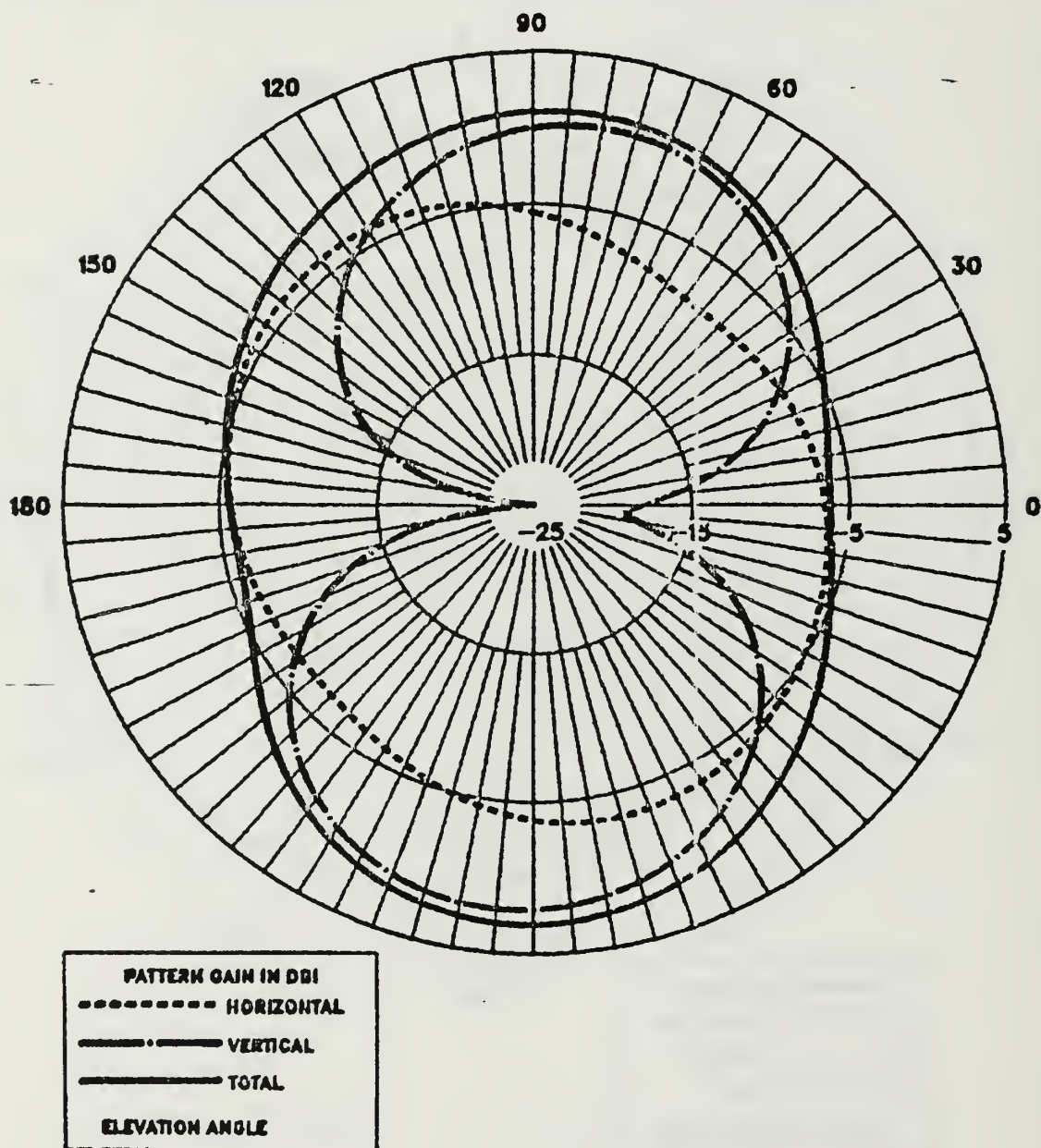
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ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CUT, THETA=26



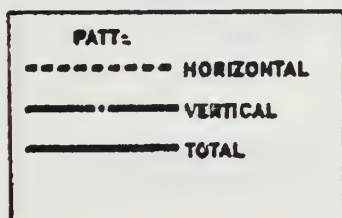
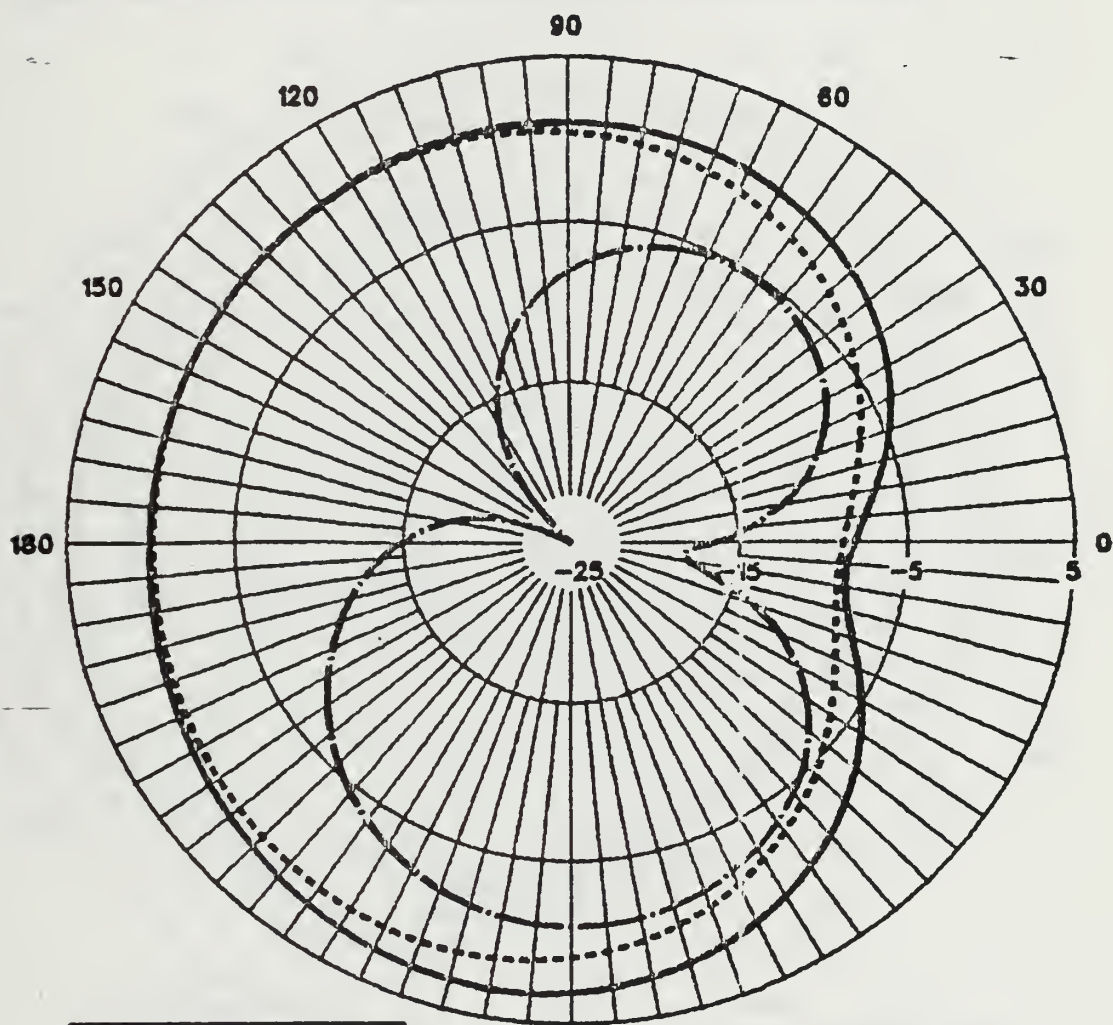
H65 IGUANA DATA RUN AT 18.1MHZ ON 8/15/87

ARMY-TYPE TUBE ANT, FREE SPACE, VERT CUT, PHI=0



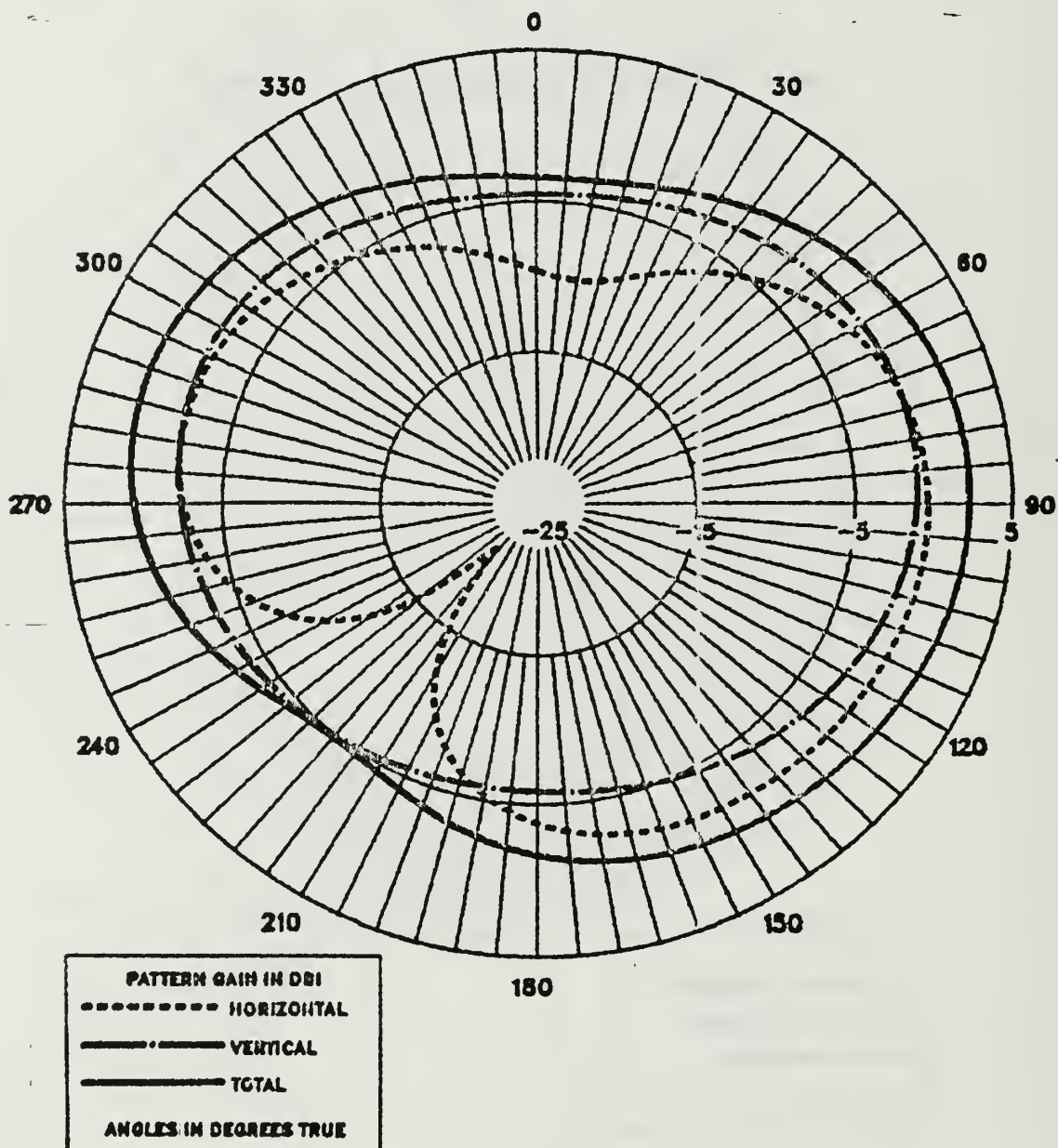
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ARMY-TYPE TUBE ANT, FREE SPACE, VERT CUT, $\text{PHI}=45$



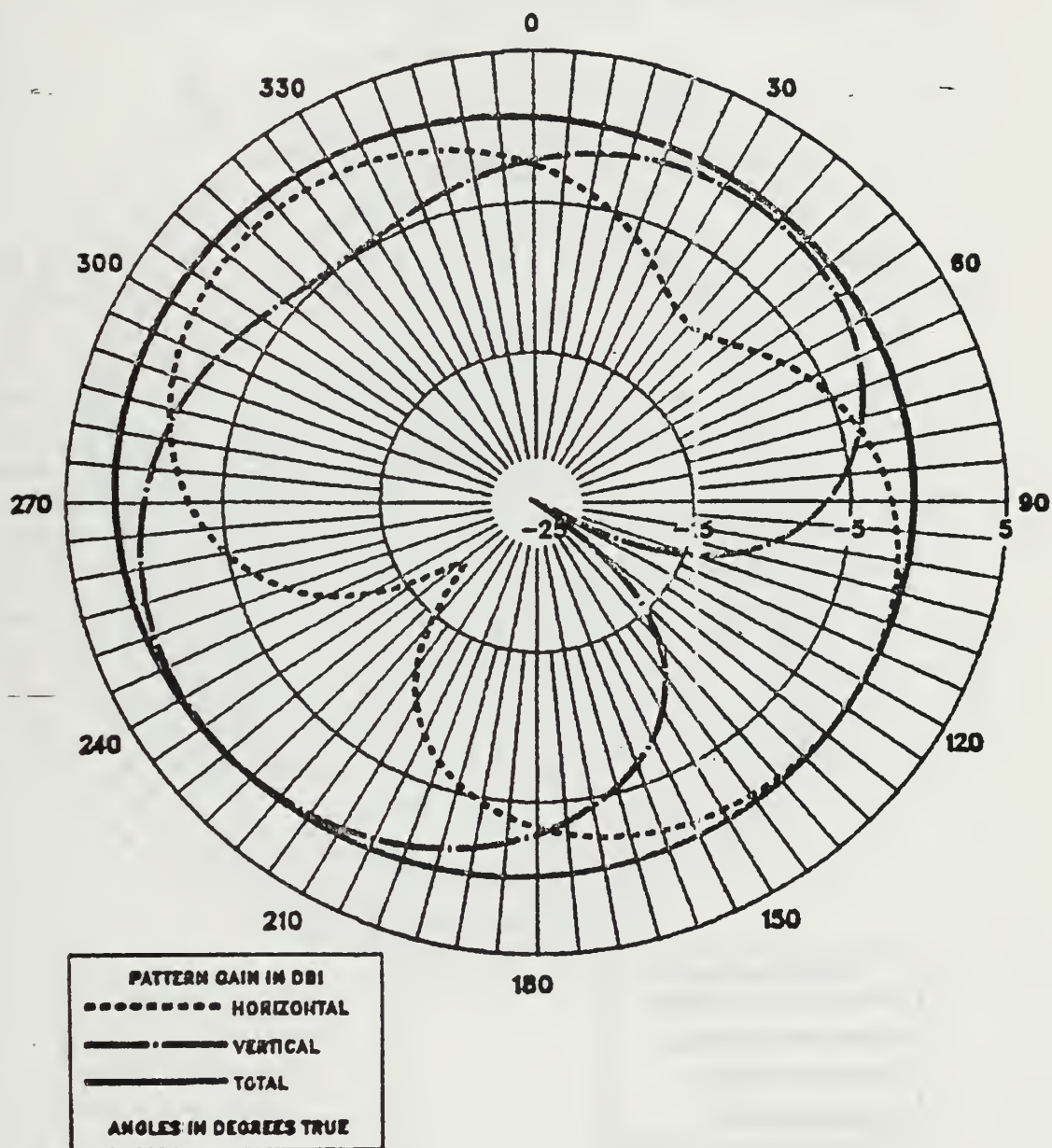
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LONG SHUNTED LOOP, FREE SPACE, HORIZ CUT, THETA=90



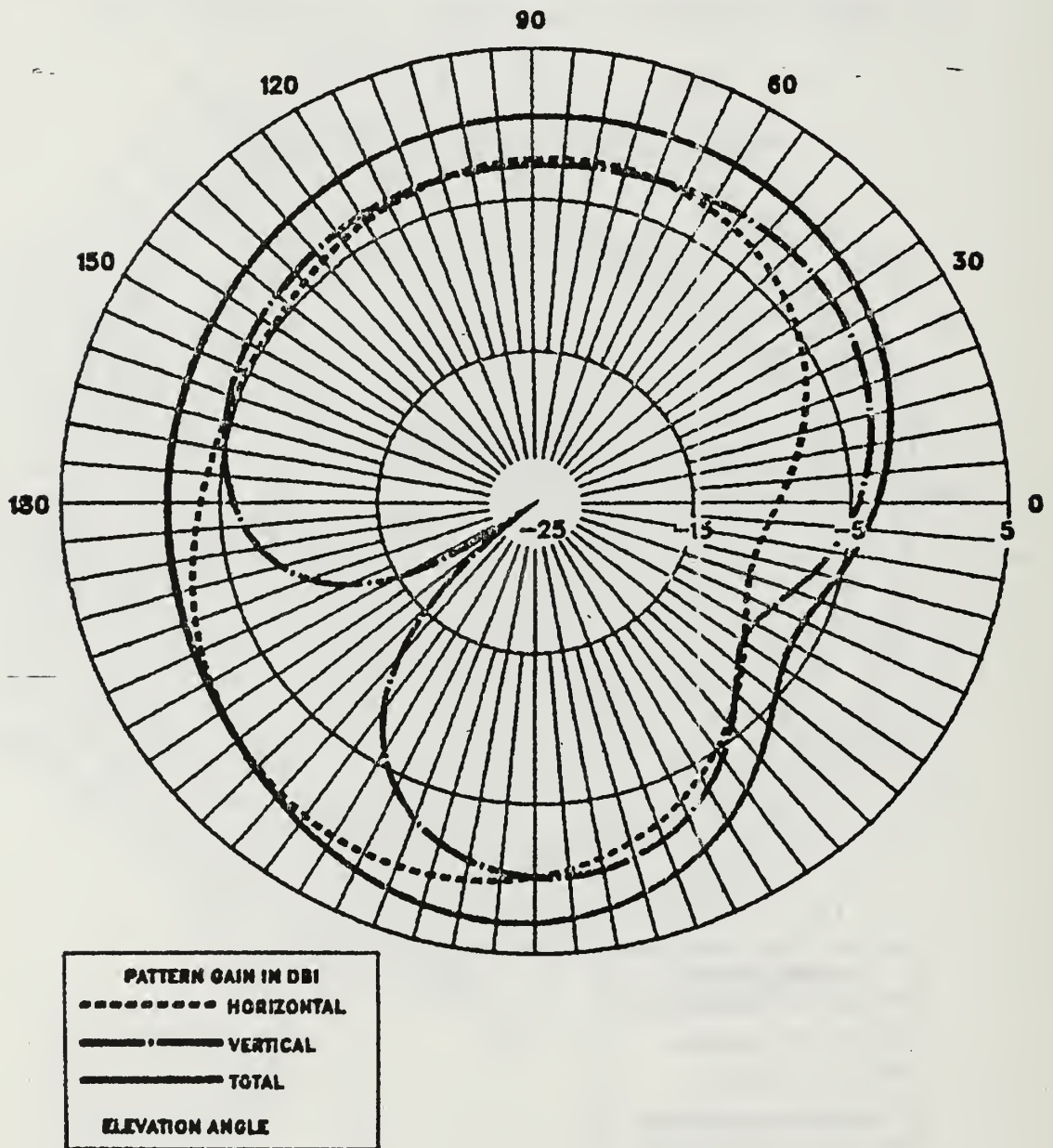
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LONG SHUNTED LOOP, FREE SPACE, HORIZ CUT, THETA=26



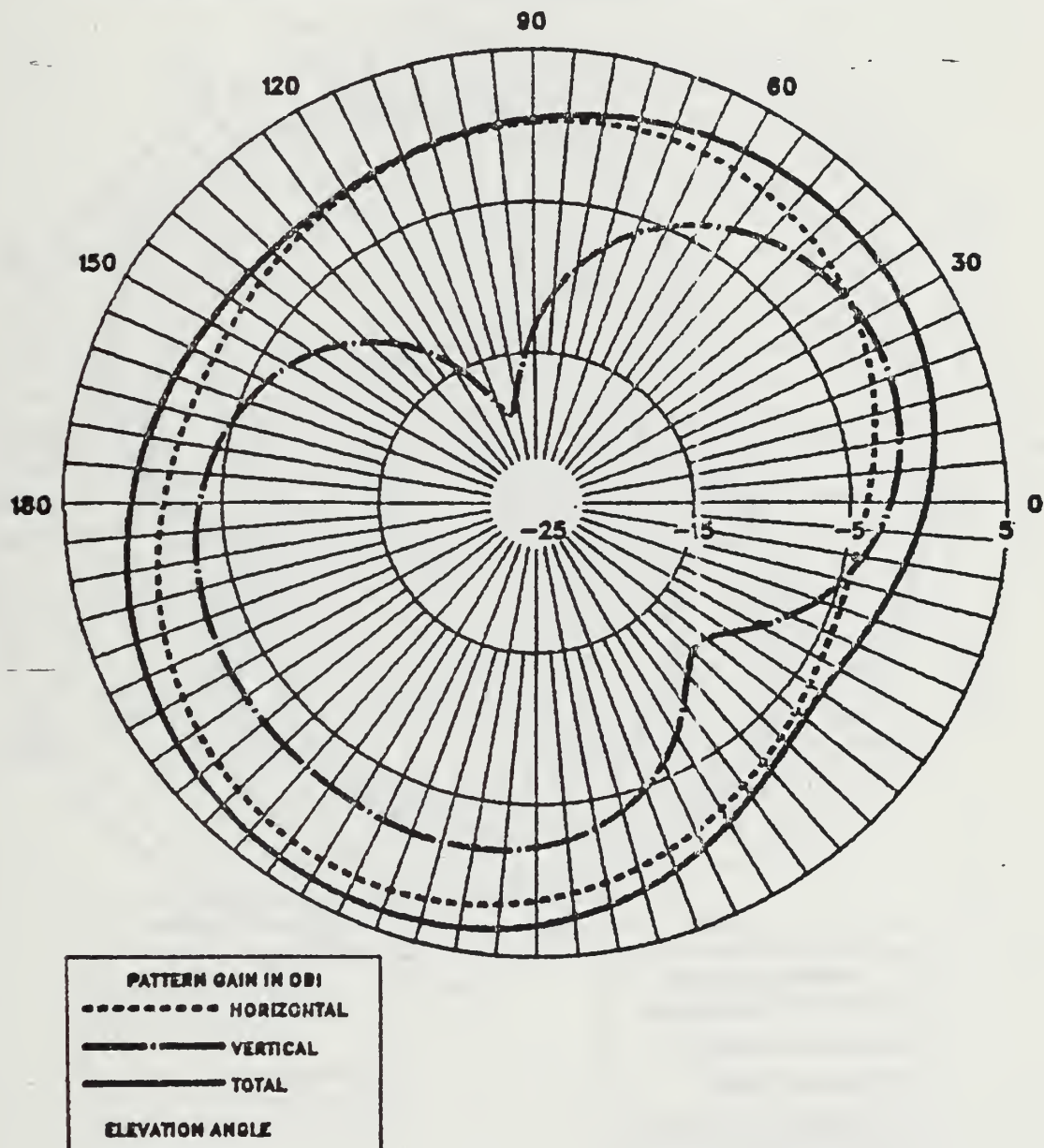
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LONG SHUNTED LOOP, FREE SPACE, VERT CUT, PHI=0



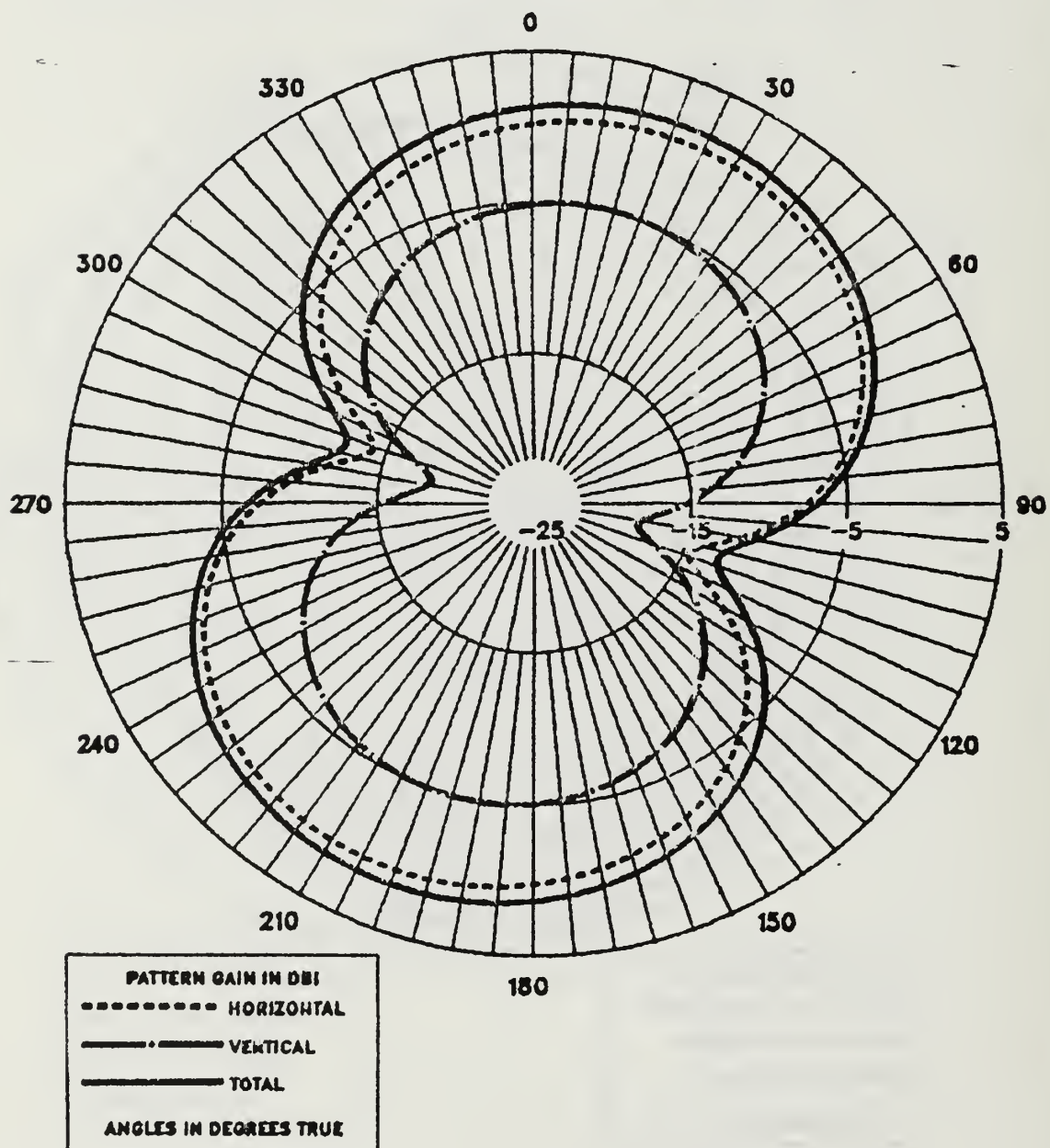
H65 IGUANA DATA RUN AT 18.1MHZ ON 8/15/87

LONG SHUNTED LOOP, FREE SPACE, VERT CUT, $\Phi=45$



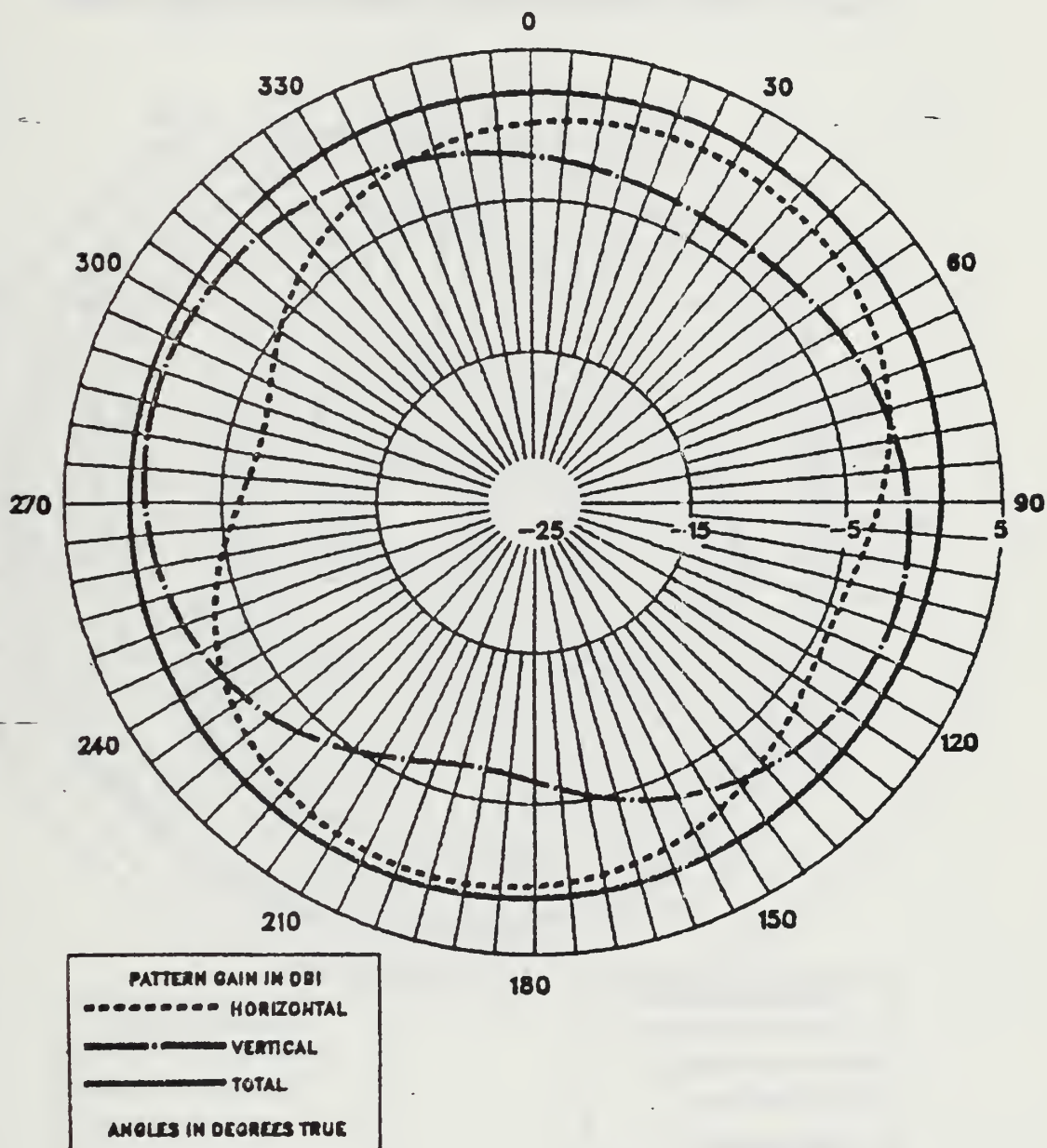
H60 IGUANA DATA RUN AT 3.123MHZ ON 8/19/87

LONG-WIRE ANT, FREE SPACE, HORIZ CUT, THETA=90



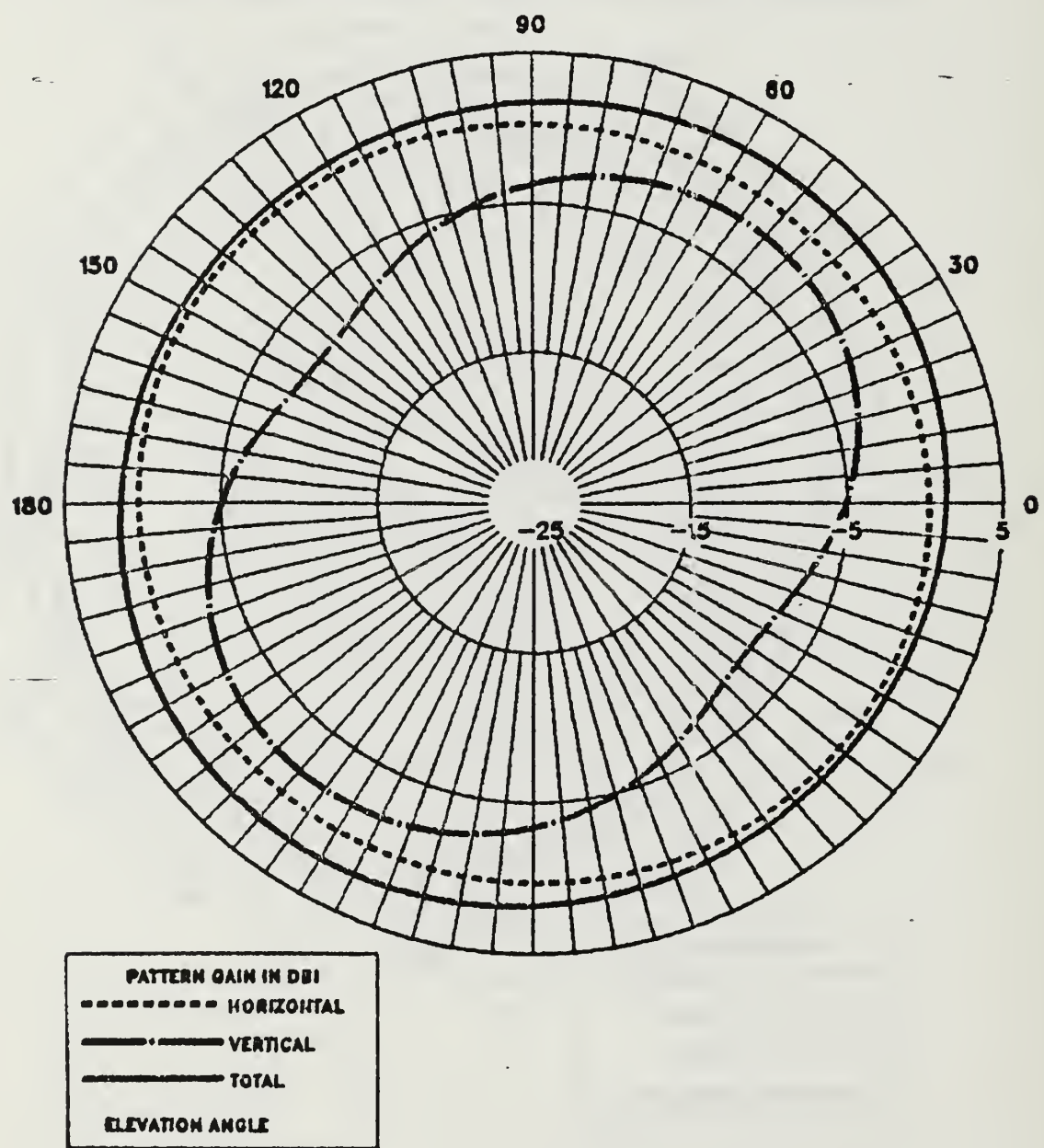
H60 IGUANA DATA RUN AT 3.123MHZ ON 8/19/87

LONG-WIRE ANT, FREE SPACE, HORIZ CUT, THETA=26



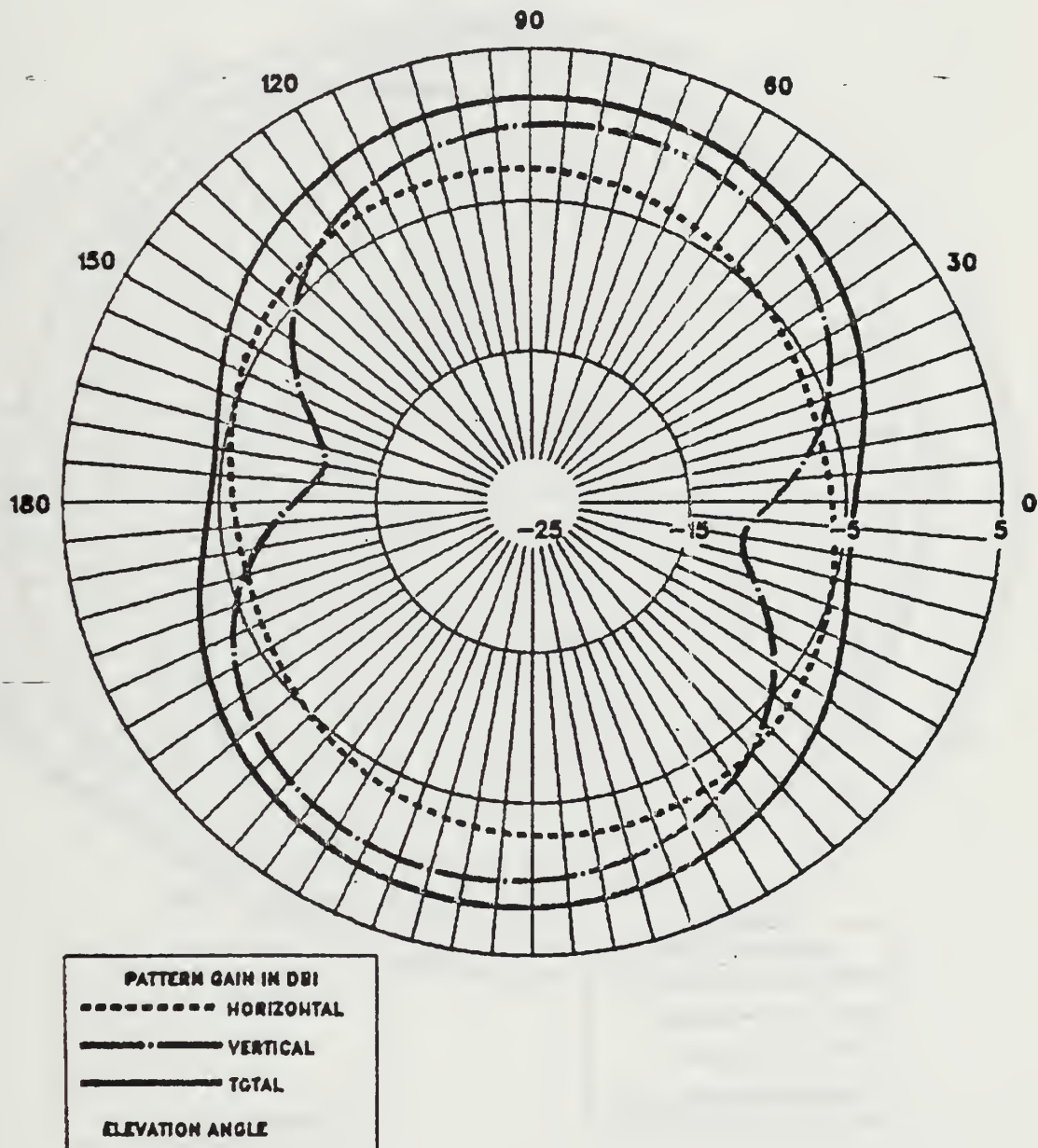
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LONG-WIRE ANT, FREE SPACE, VERT CUT, PHI=0



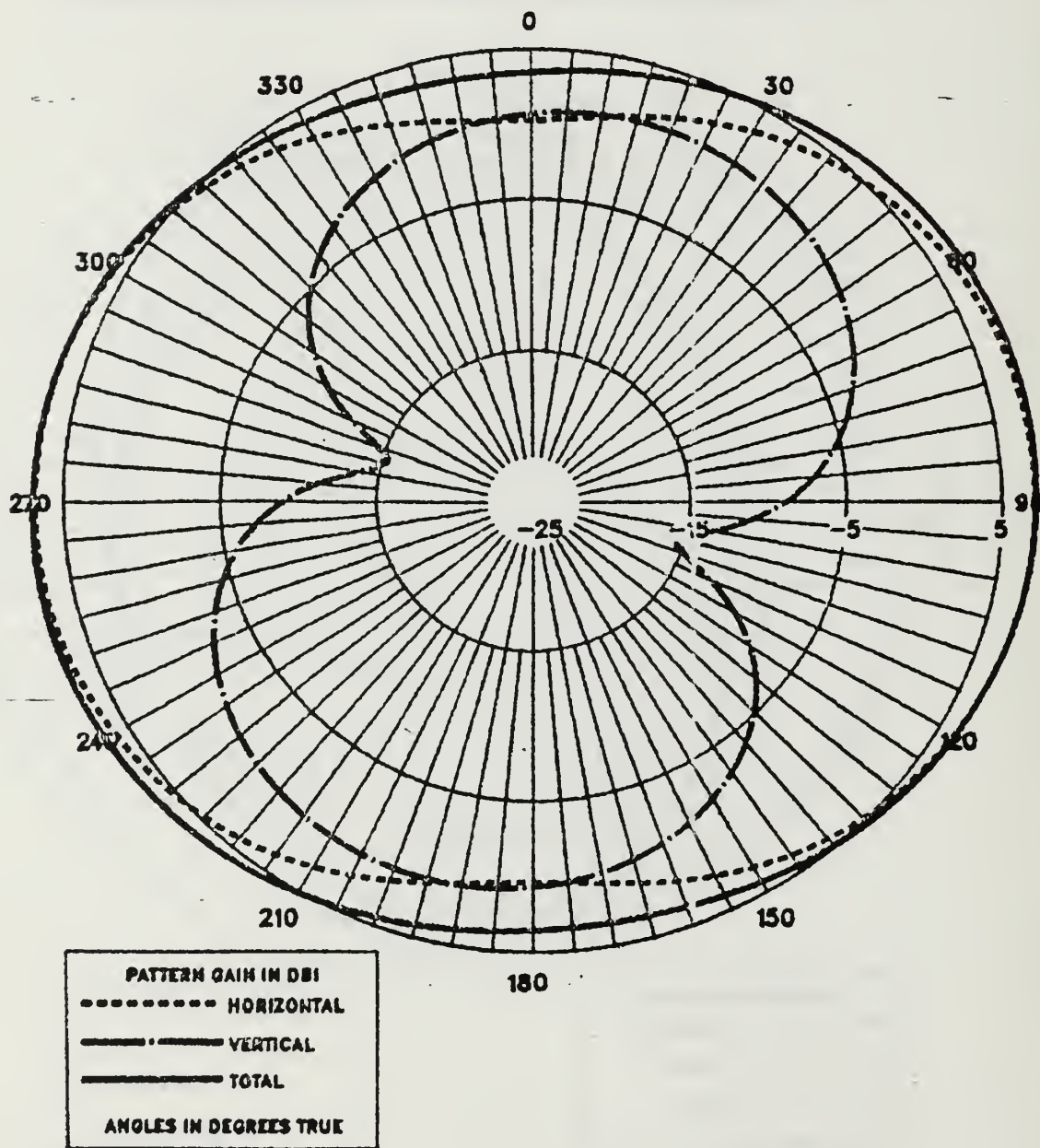
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LONG-WIRE ANT, FREE SPACE, VERT CUT, PHI=45



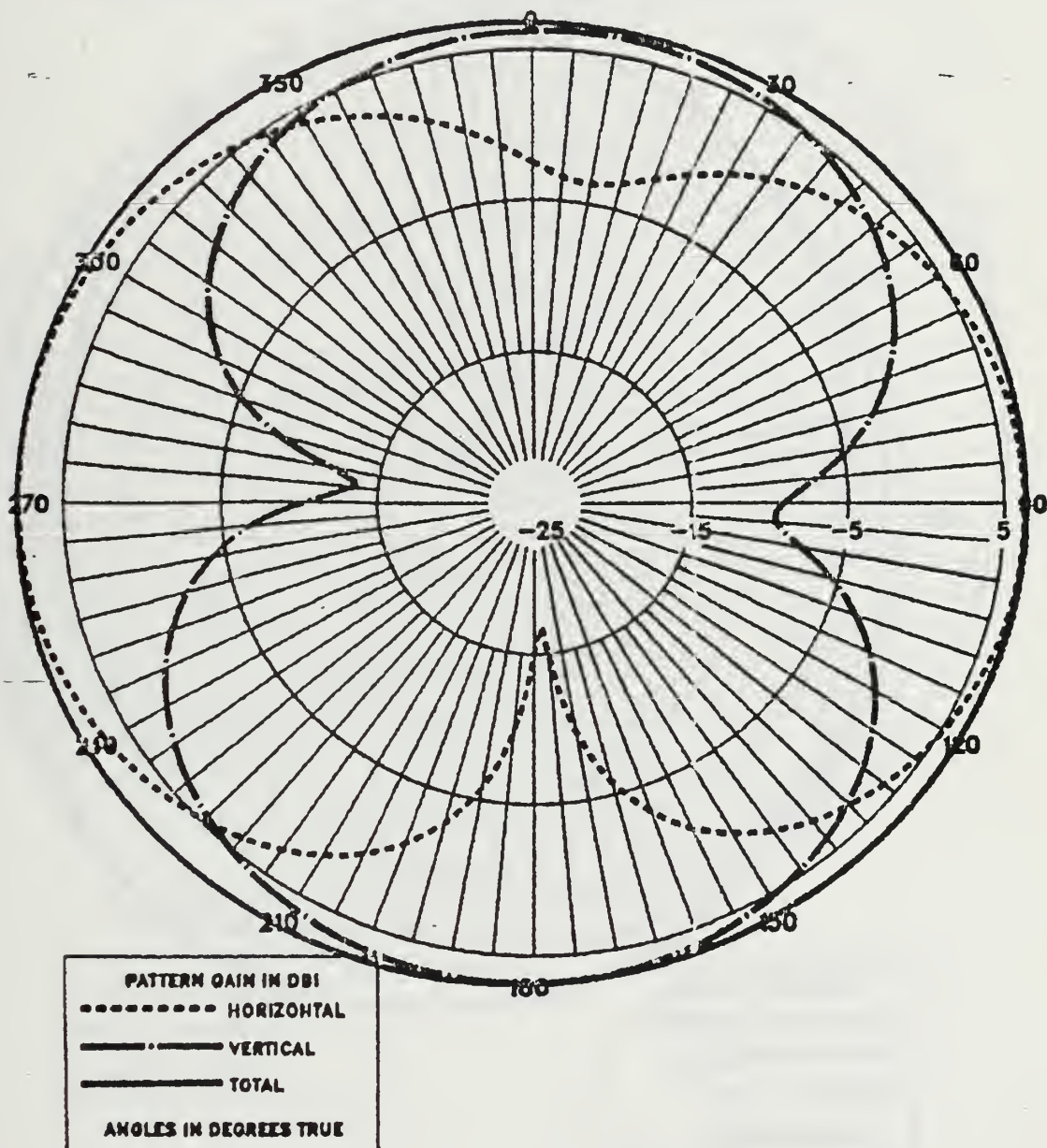
H60 IGUANA DATA RUN AT 3.123MHZ ON 8/19/87

NAVY 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=90



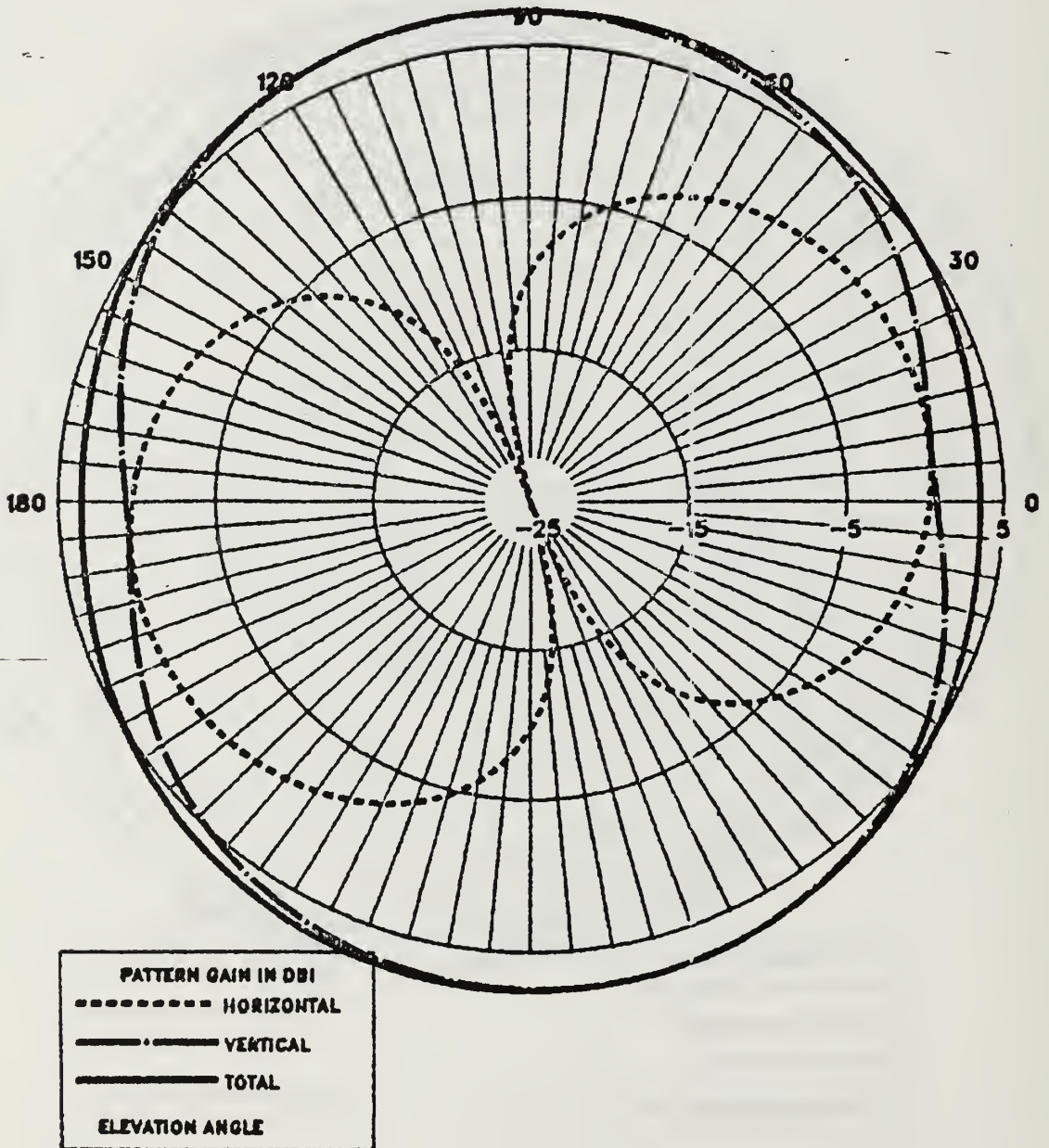
H60 IGUANA DATA RUN AT 3.123MHZ ON 8/19/87

NAVY 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=26



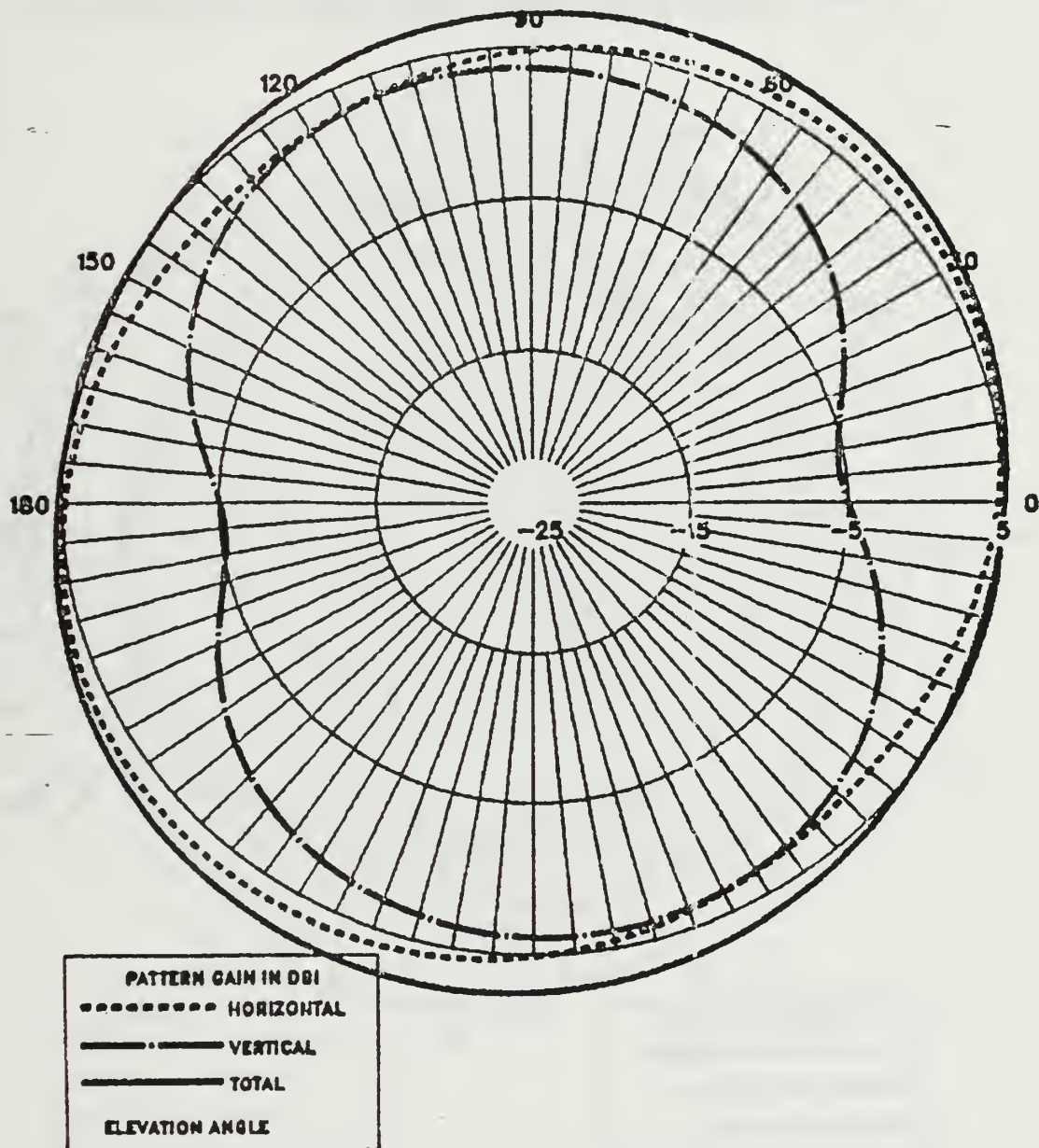
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NAVY 437R-2 ANT, FREE SPACE, VERT CUT, PHI=0



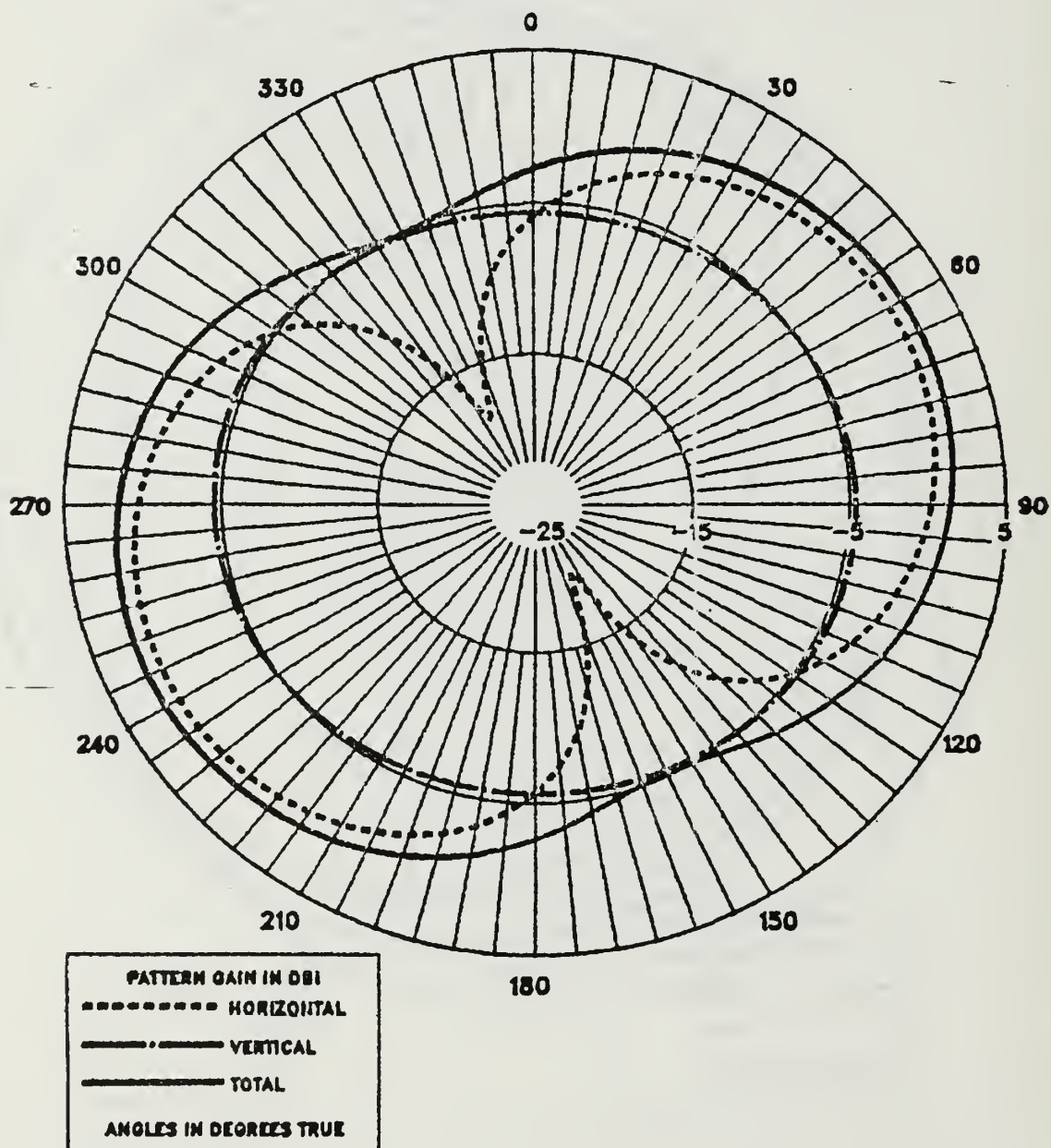
H60 IGUANA DATA RUN AT 3.123MHZ ON 8/19/87

NAVY 437R-2 ANT, FREE SPACE, VERT CUT, $\Phi=45$



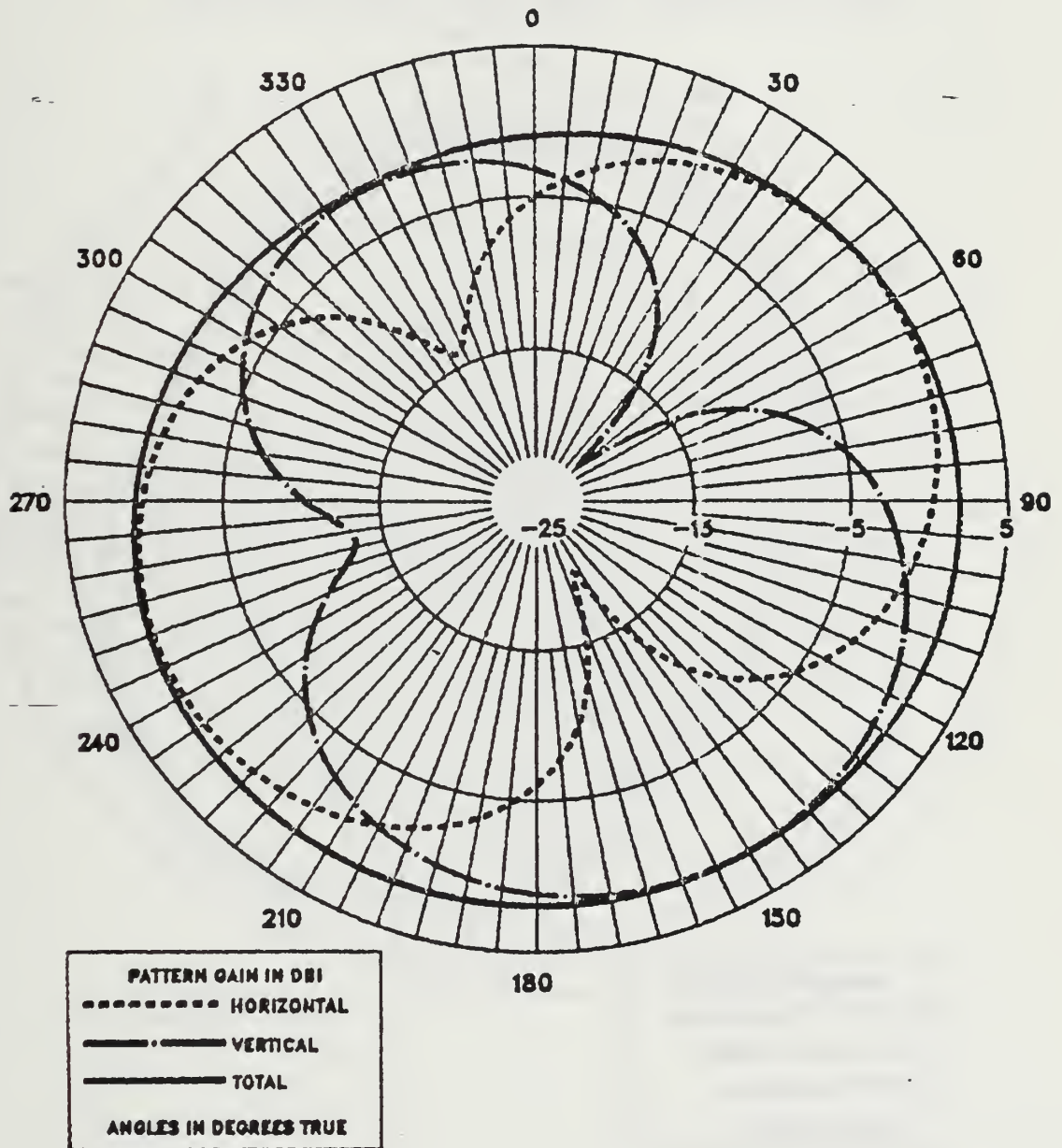
H60 IGUANA DATA RUN AT 3.123MHZ ON 8/19/87

CG 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=90



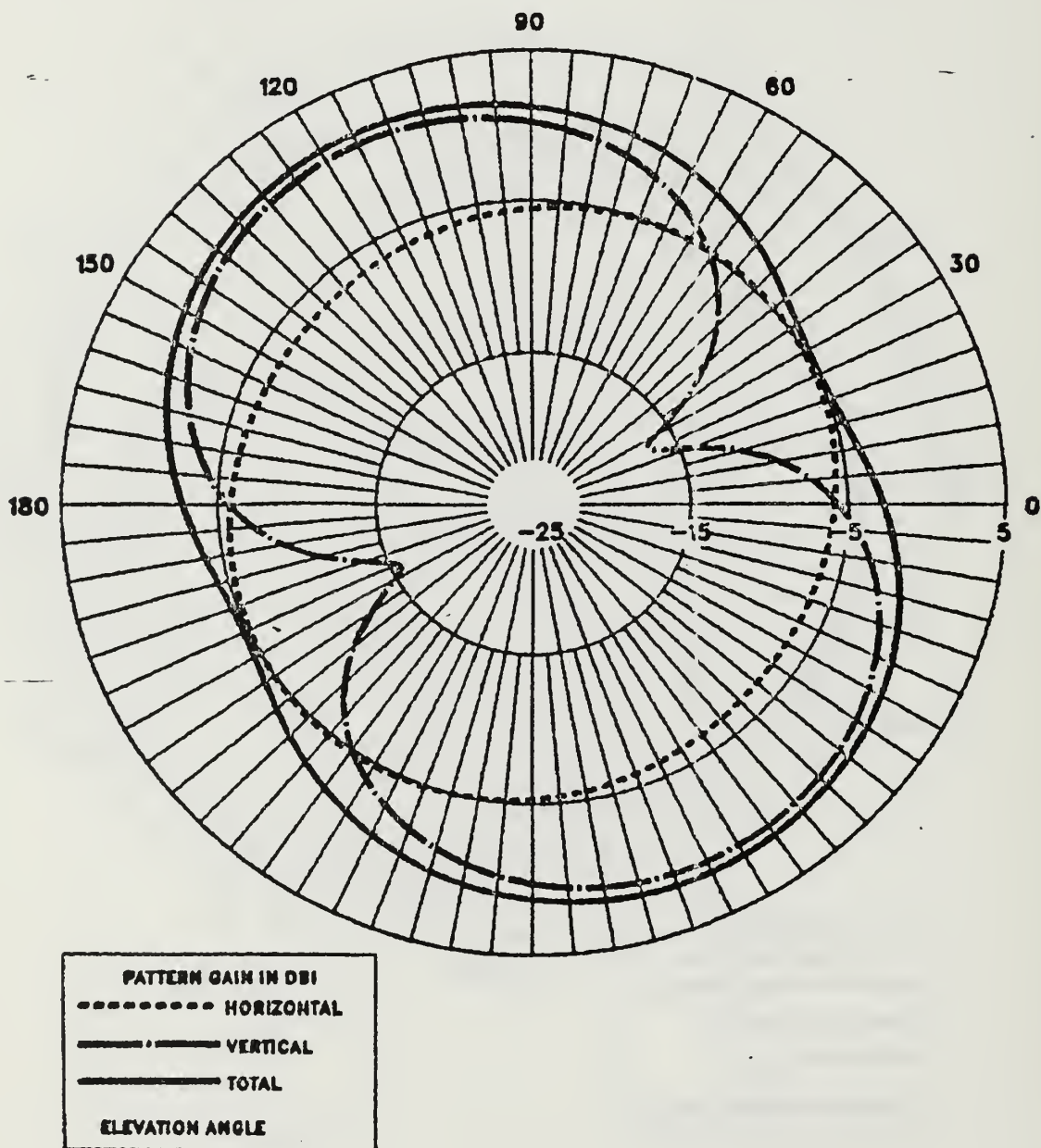
H60 IGUANA DATA RUN AT 3.123MHZ ON 8/19/87

CG 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=26



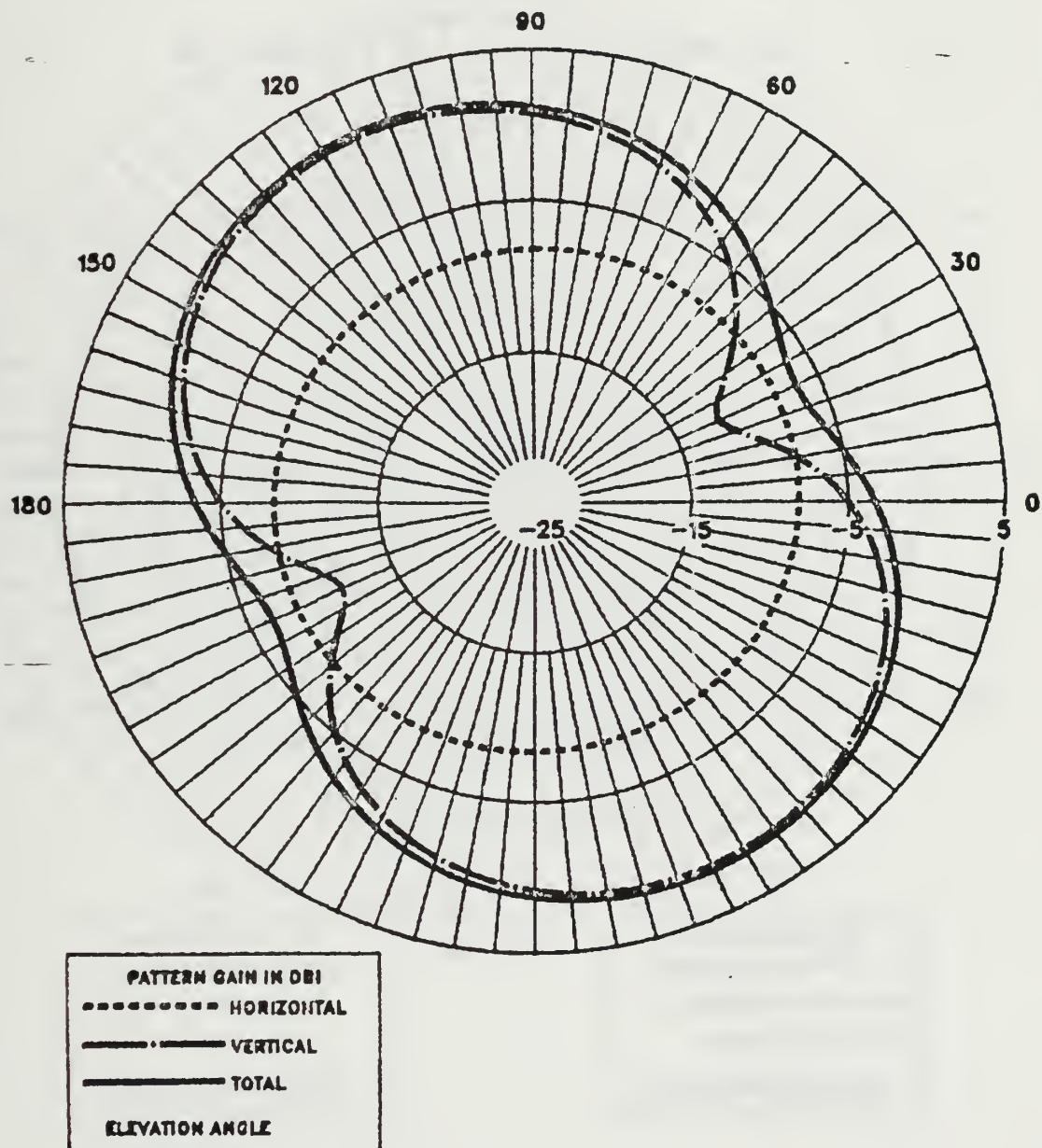
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CG 437R-2 ANT, FREE SPACE, VERT CUT, PHI=0



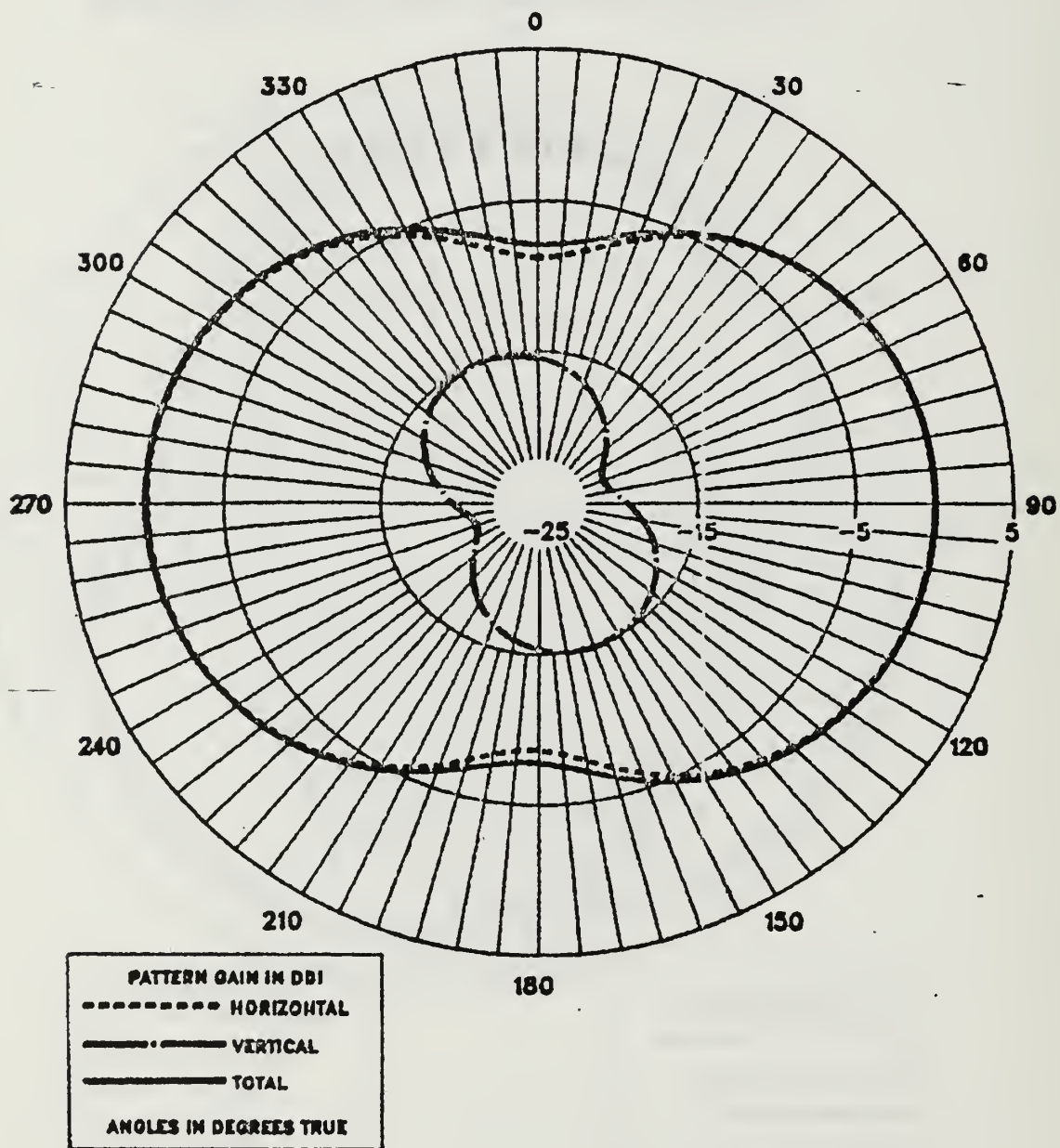
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CG 437R-2 ANT, FREE SPACE, VERT CUT, PHI=45



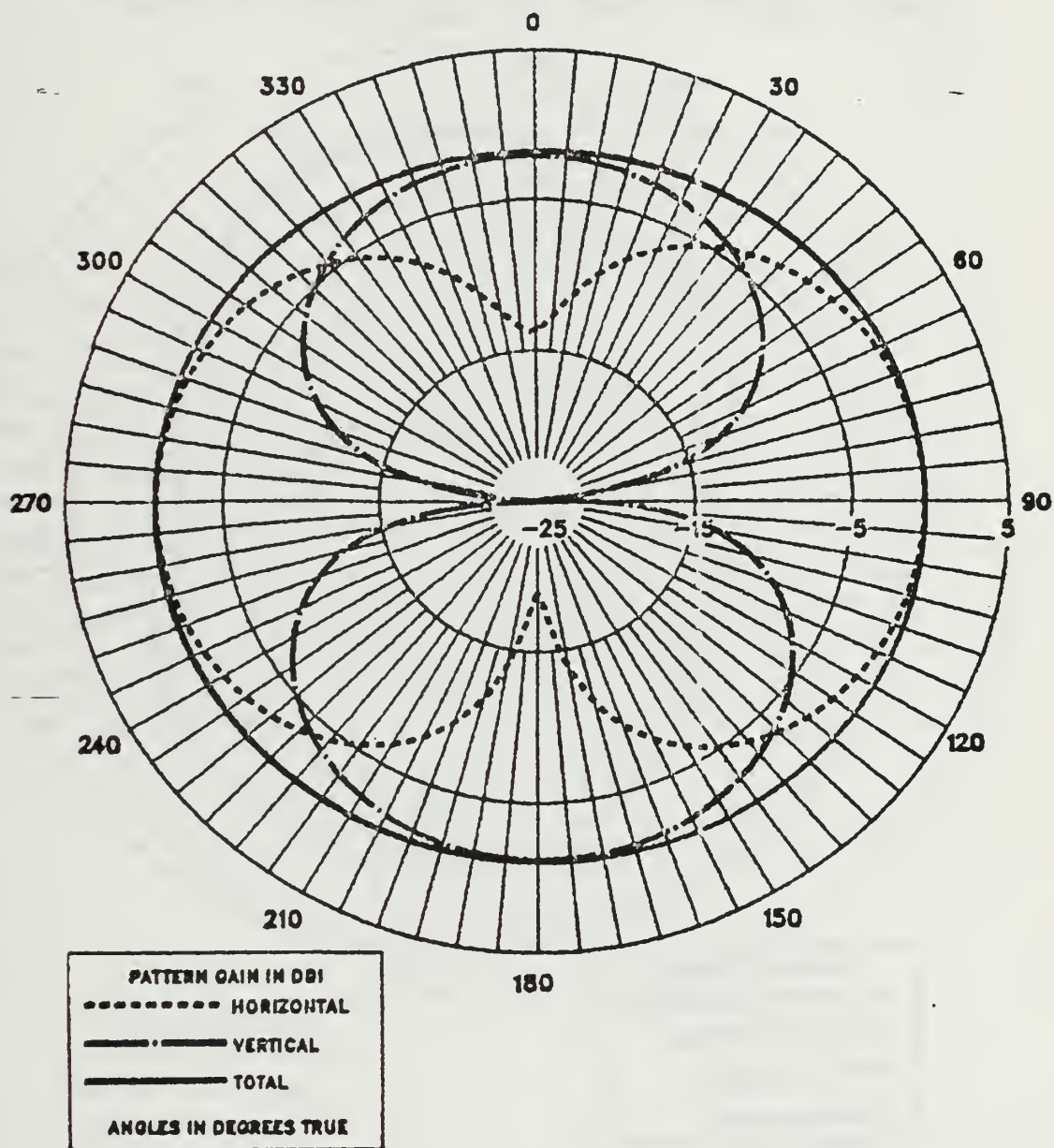
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ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CTU, THETA=90



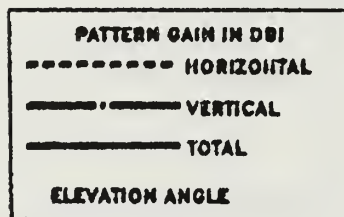
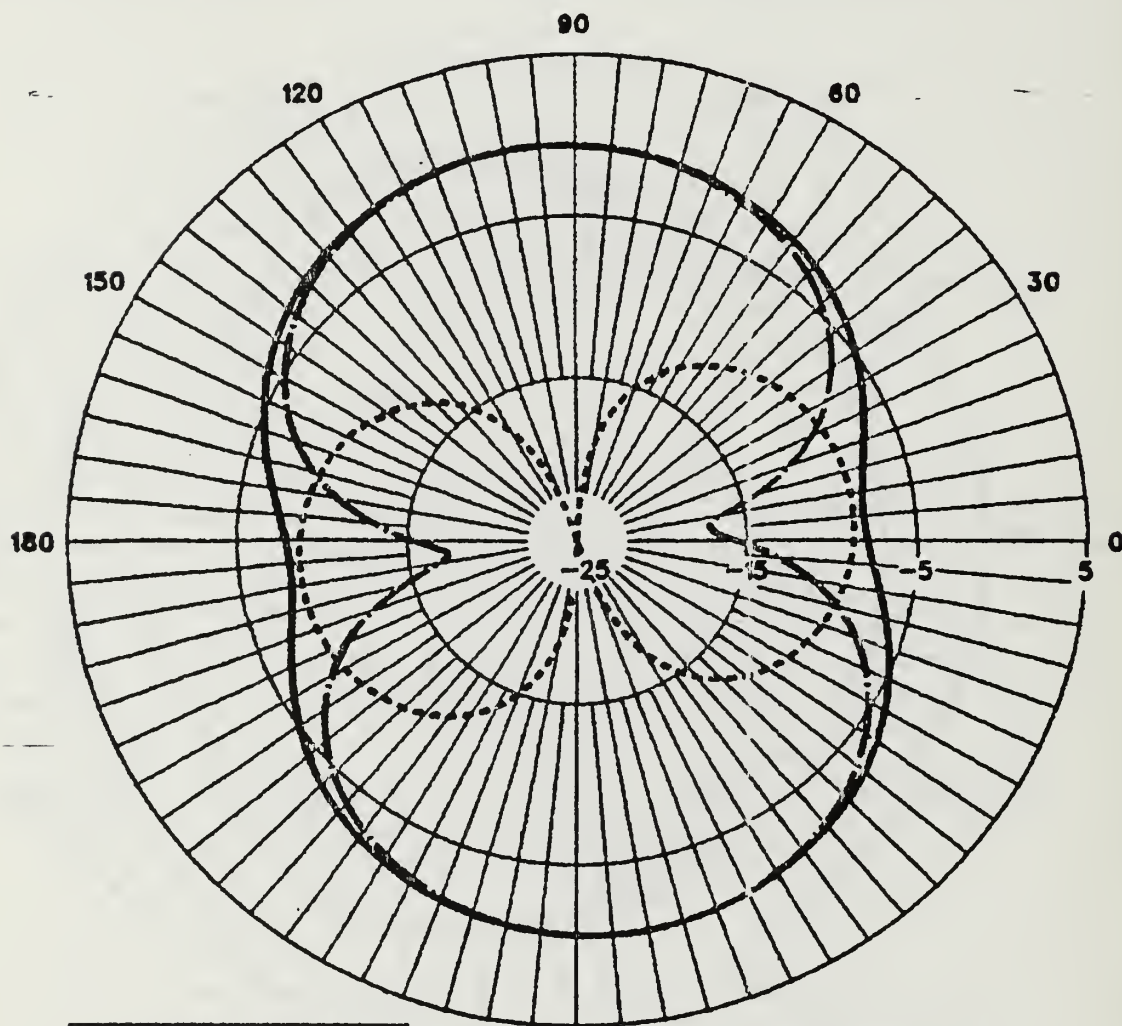
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ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CUT, THETA=26



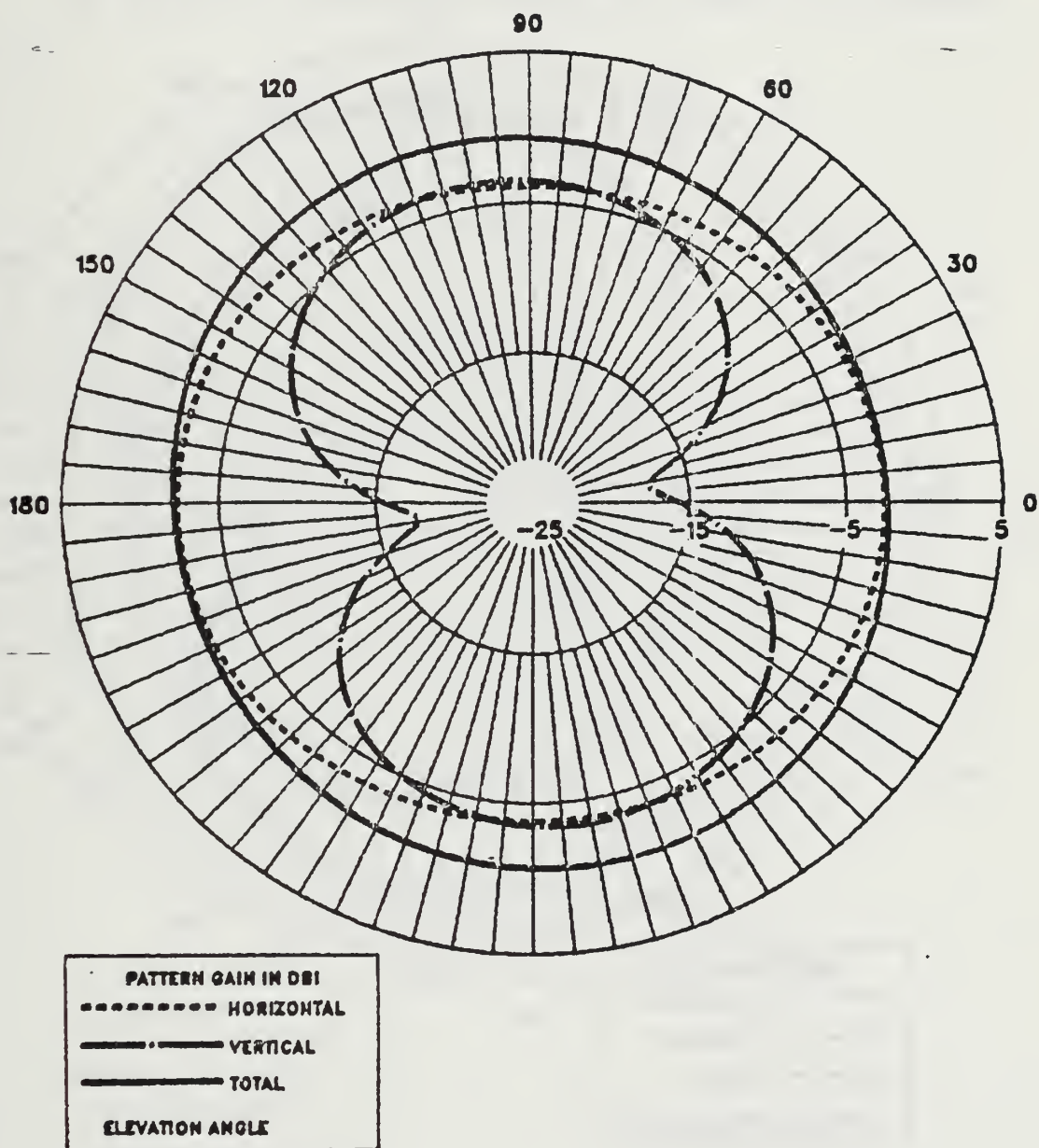
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ARMY--TYPE TUBE ANT, FREE SPACE, VERT CUT, PHI=0



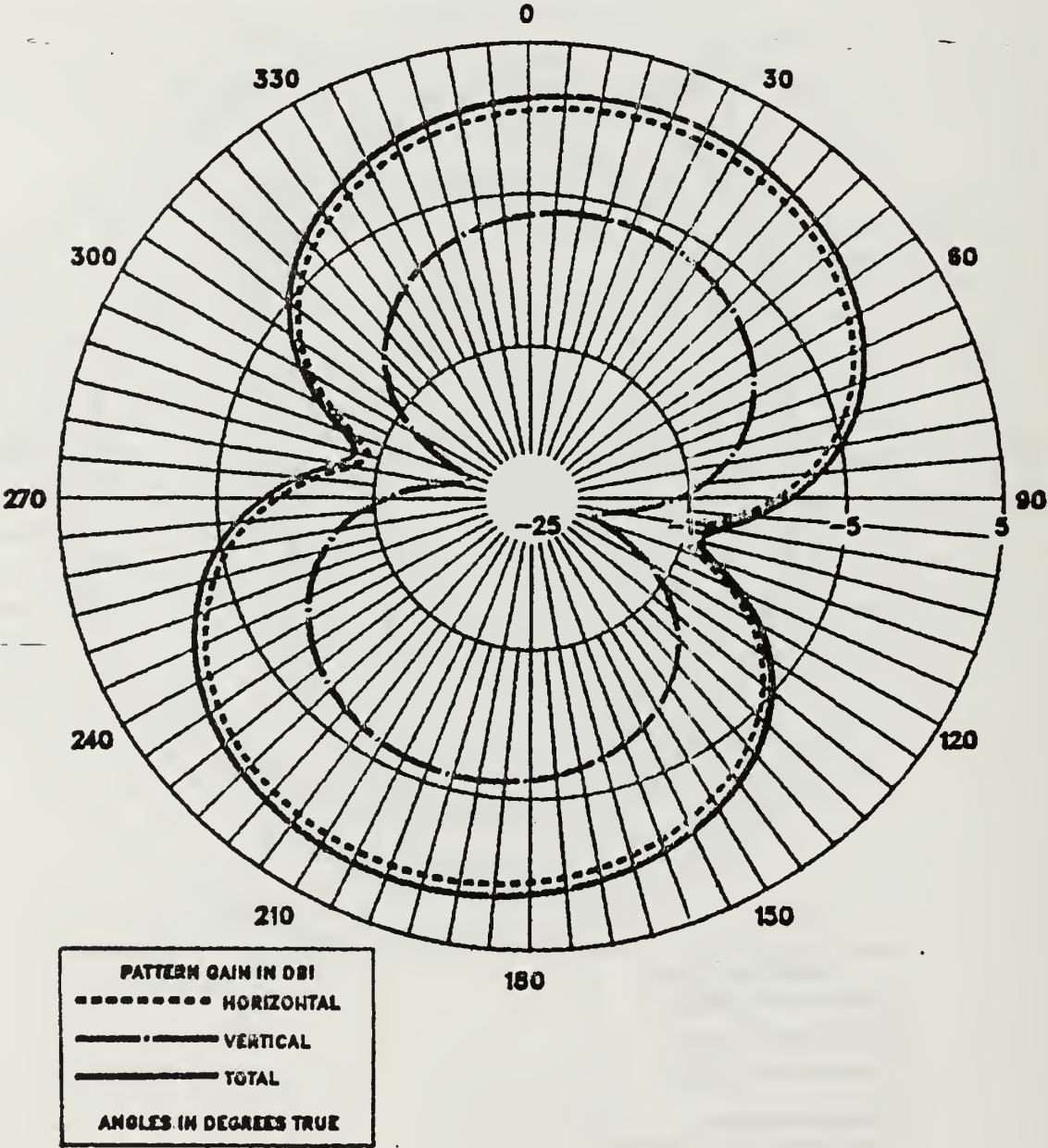
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ARMY-TYPE TUBE ANT, FREE SPACE, VERT CUT, PHI=45



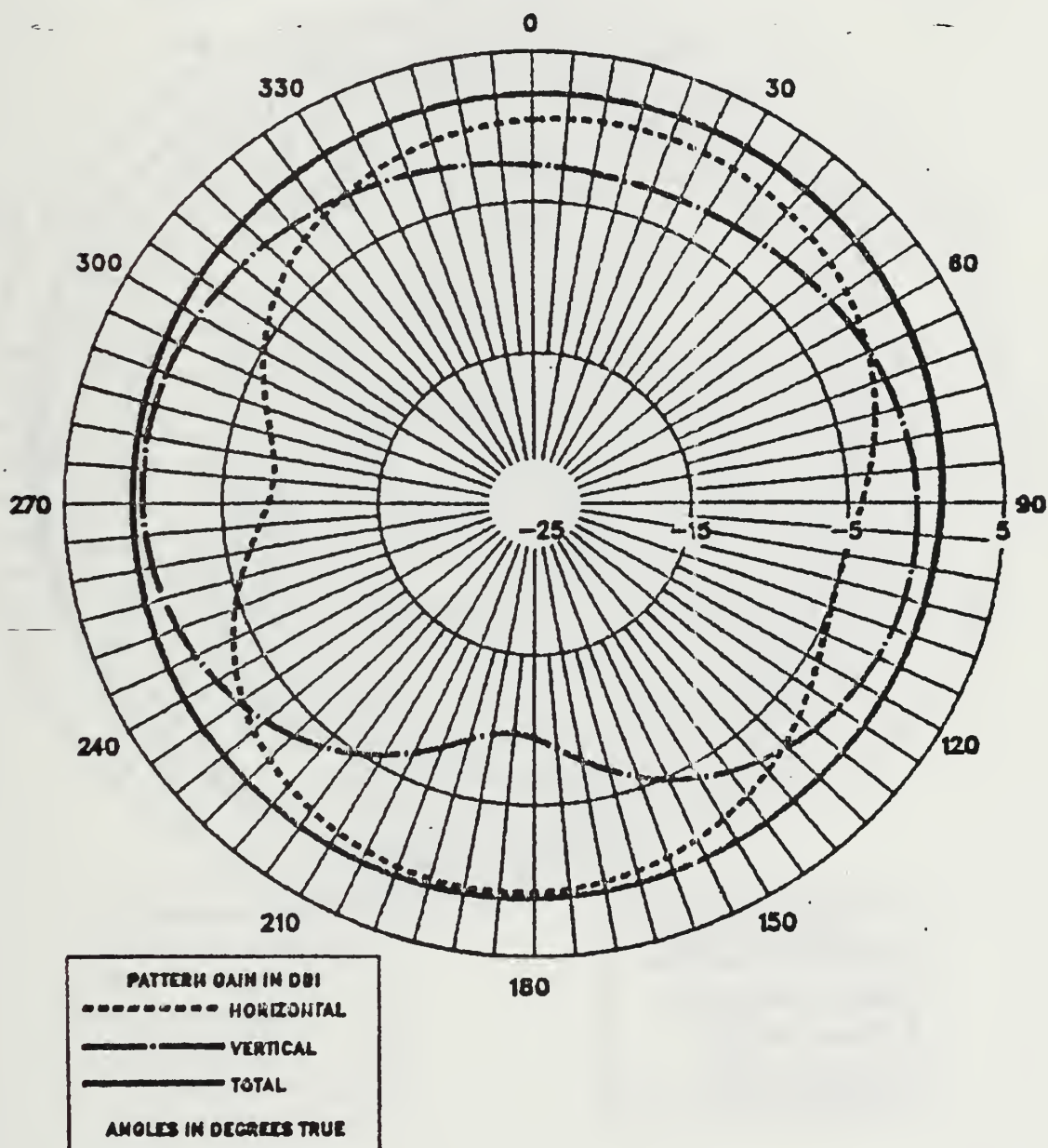
H60 IGUANA DATA RUN AT 4.040MHZ ON 8/18/87

LW SPACED 18" FROM A/C, FREE SPACE, HORIZ CUT, THETA=90



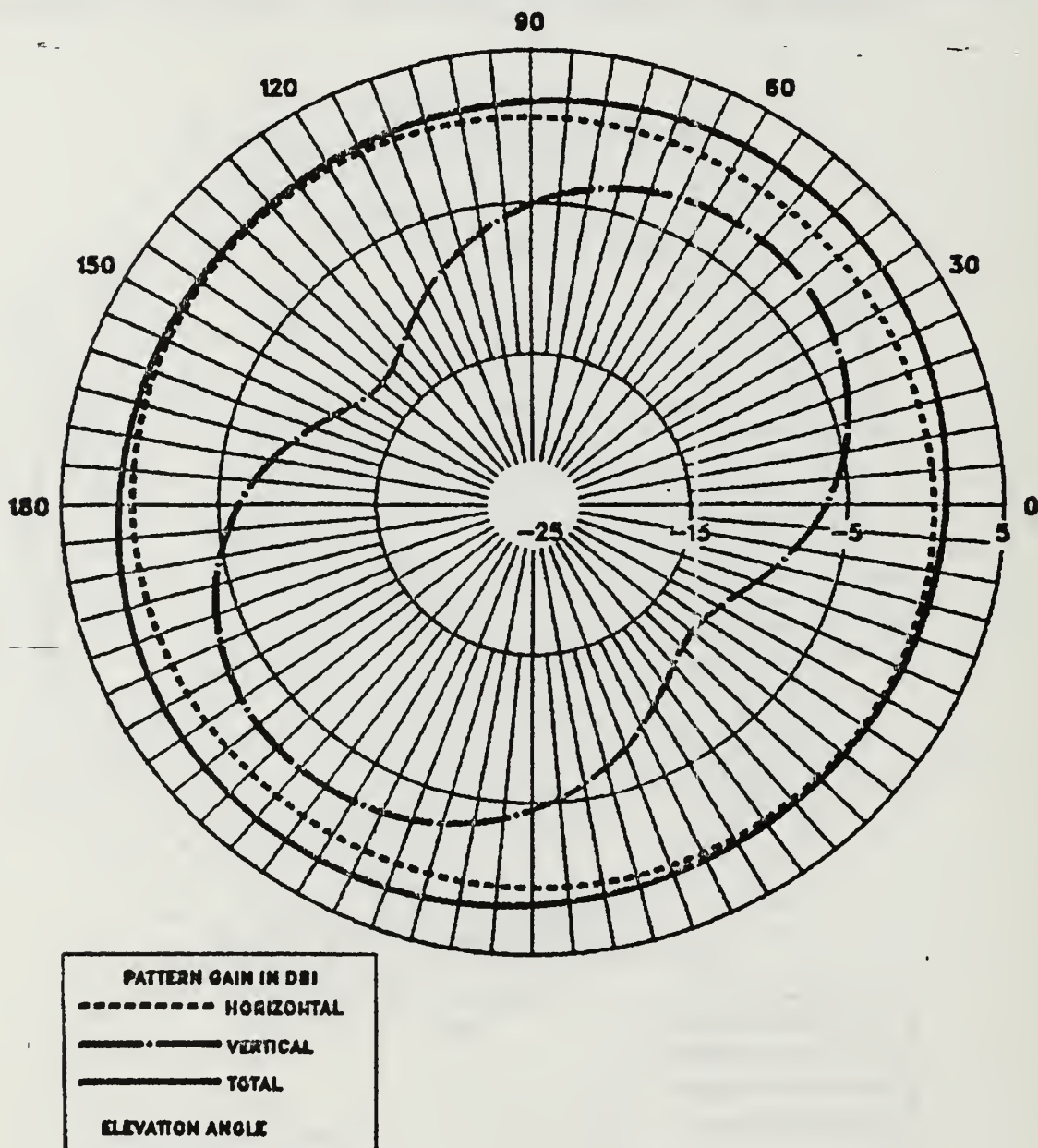
H60 IGUANA DATA RUN AT 4.040MHZ ON 8/18/87

LW SPACED 18" FROM A/C, FREE SPACE, HORIZ CUT, THETA=26



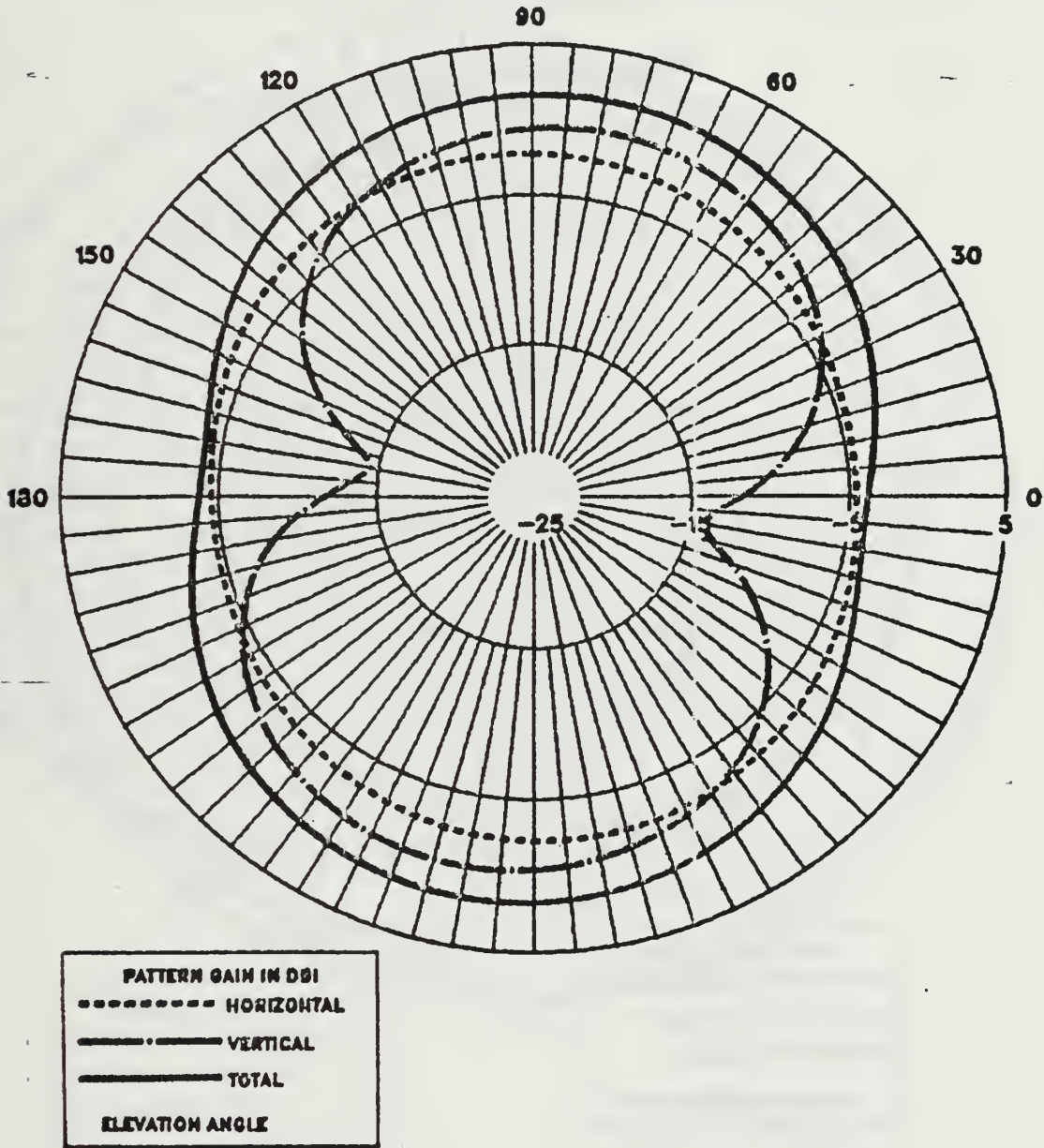
H60 IGUANA DATA RUN AT 4.040MHZ ON 8/18/87

LW SPACED 18" FROM A/C, FREE SPACE, VERT CUT, PHI=0



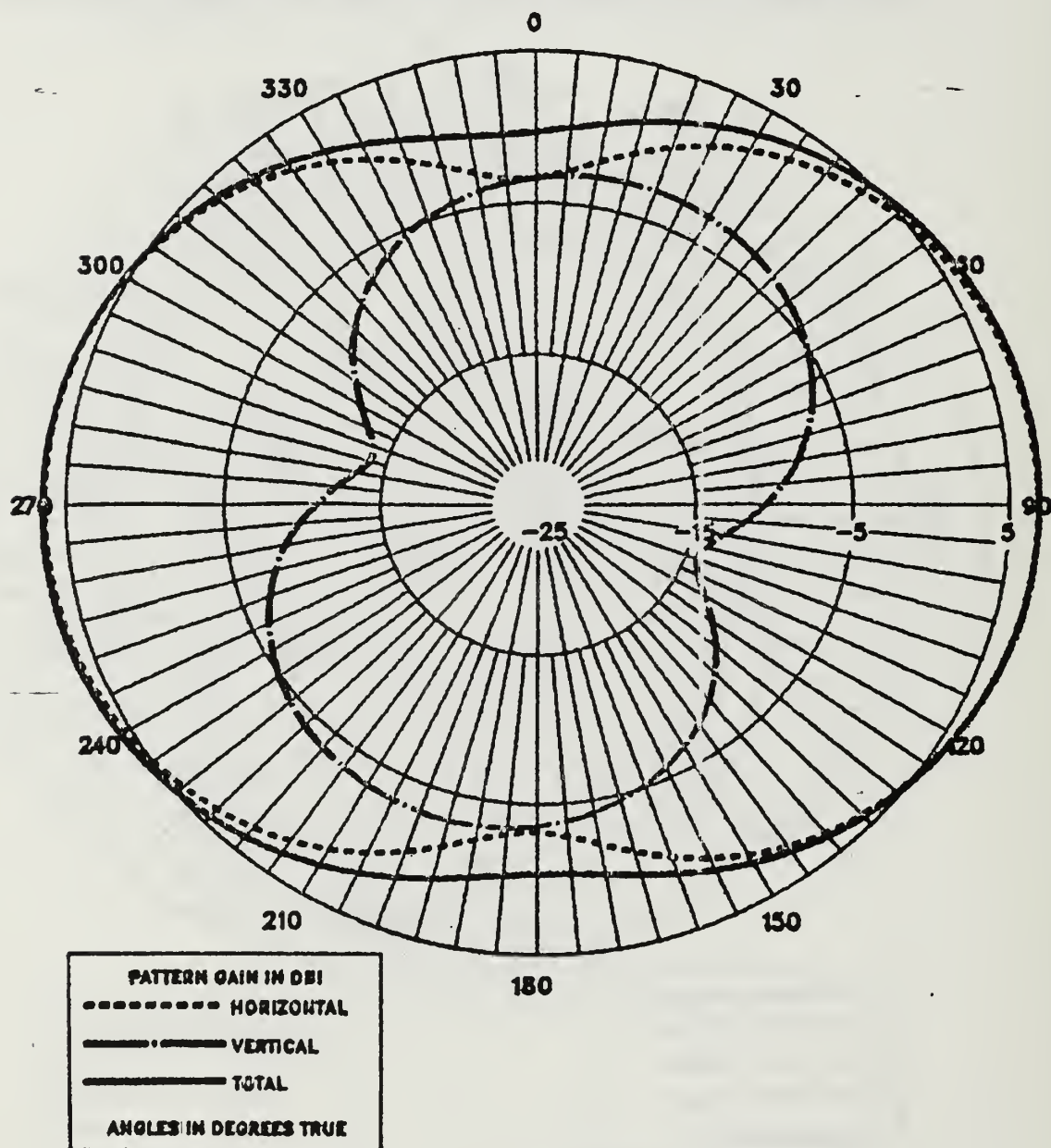
H60 IGUANA DATA RUN AT 4.040MHZ ON 8/18/87

LW SPACED 18" FROM A/C, FREE SPACE, VERT CUT, PHI=45



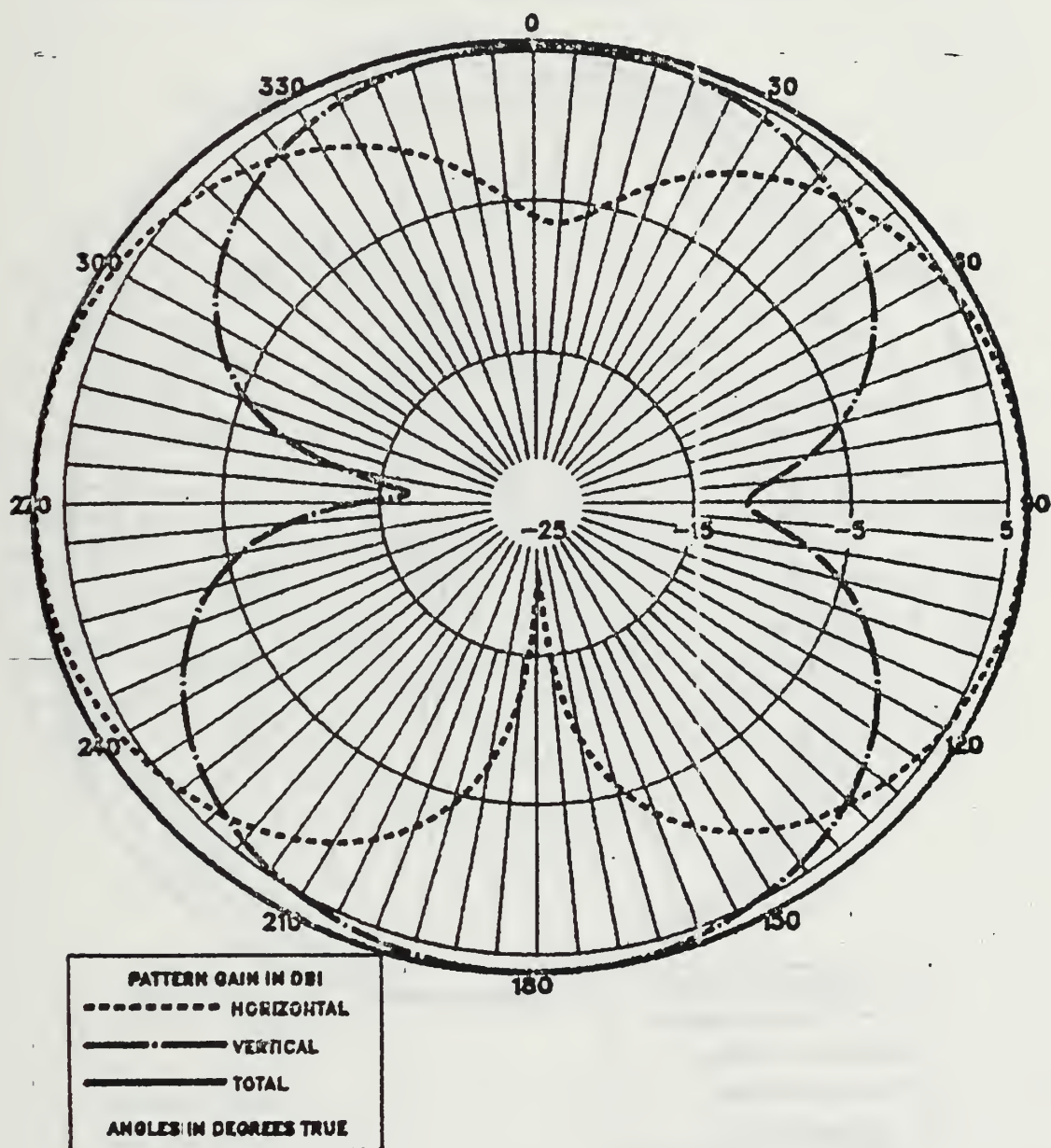
H60 IGUANA DATA RUN AT 4.040MHZ ON 8/18/87

NAVY 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=90



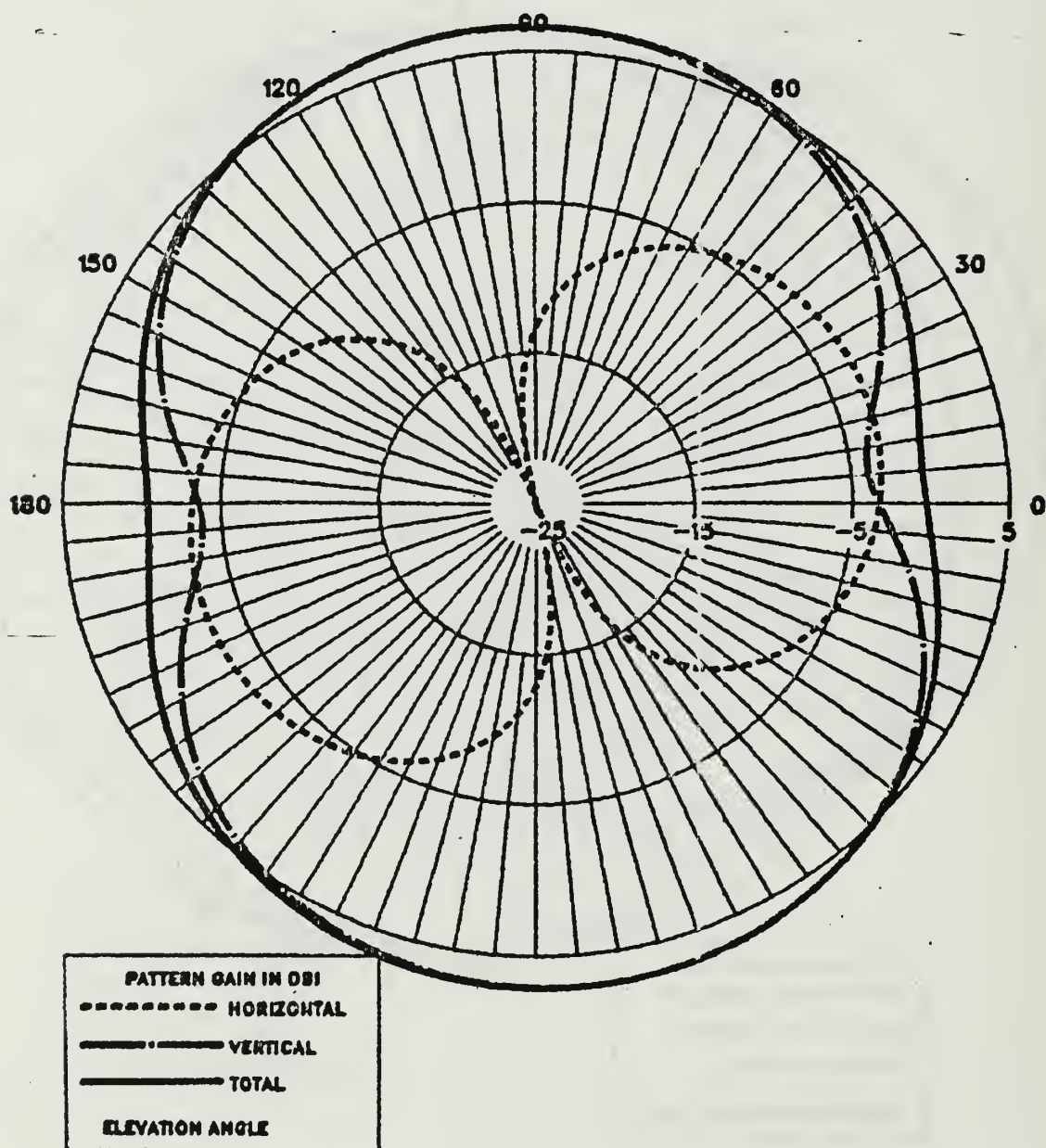
H60 IGUANA DATA RUN AT 4.040MHZ ON 8/18/87

NAVY 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=26



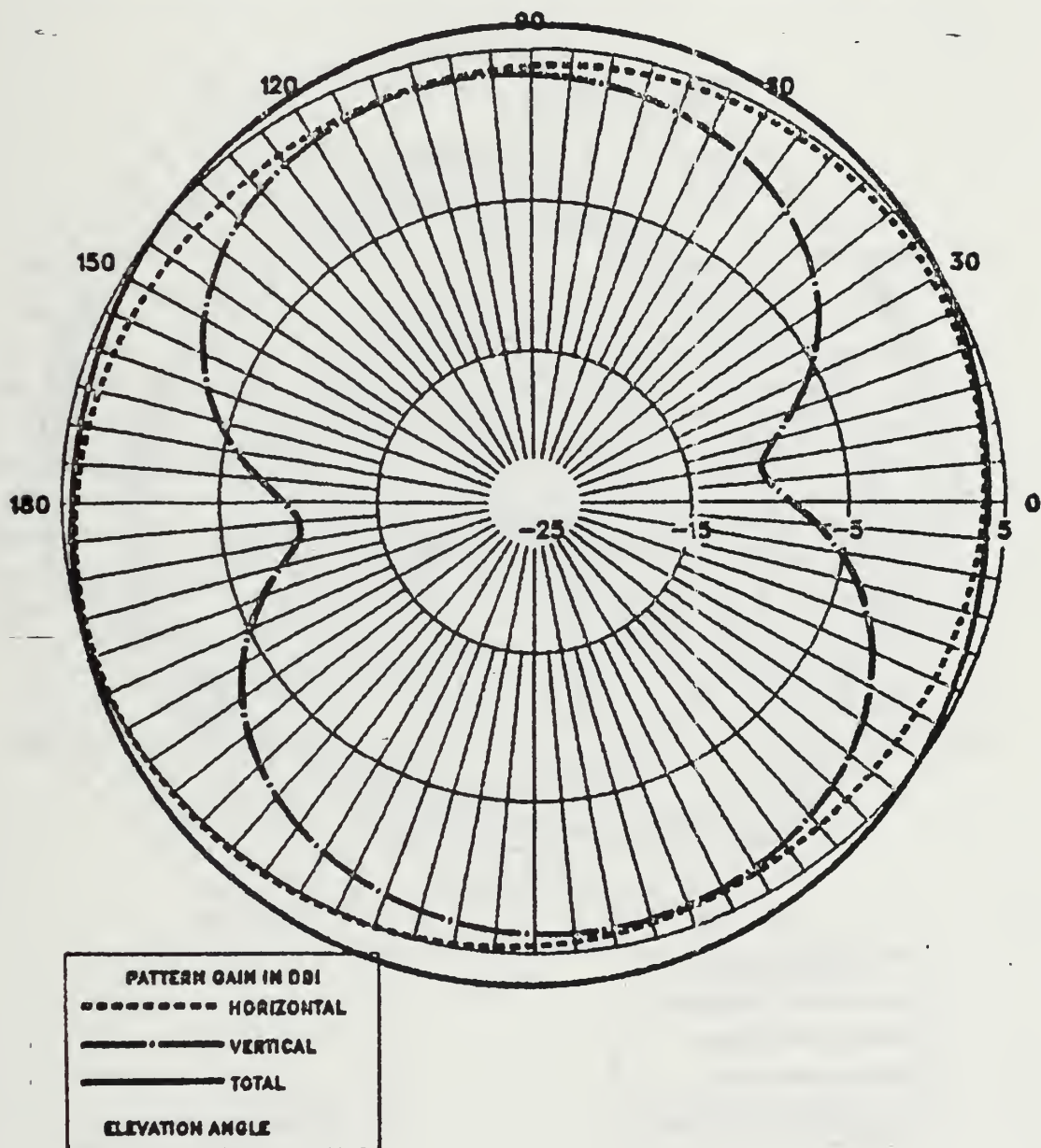
H60 IGUANA DATA RUN AT 4.040MHZ ON 8/18/87

NAVY 437R-2 ANT, FREE SPACE, VERT CUT, PHI=0



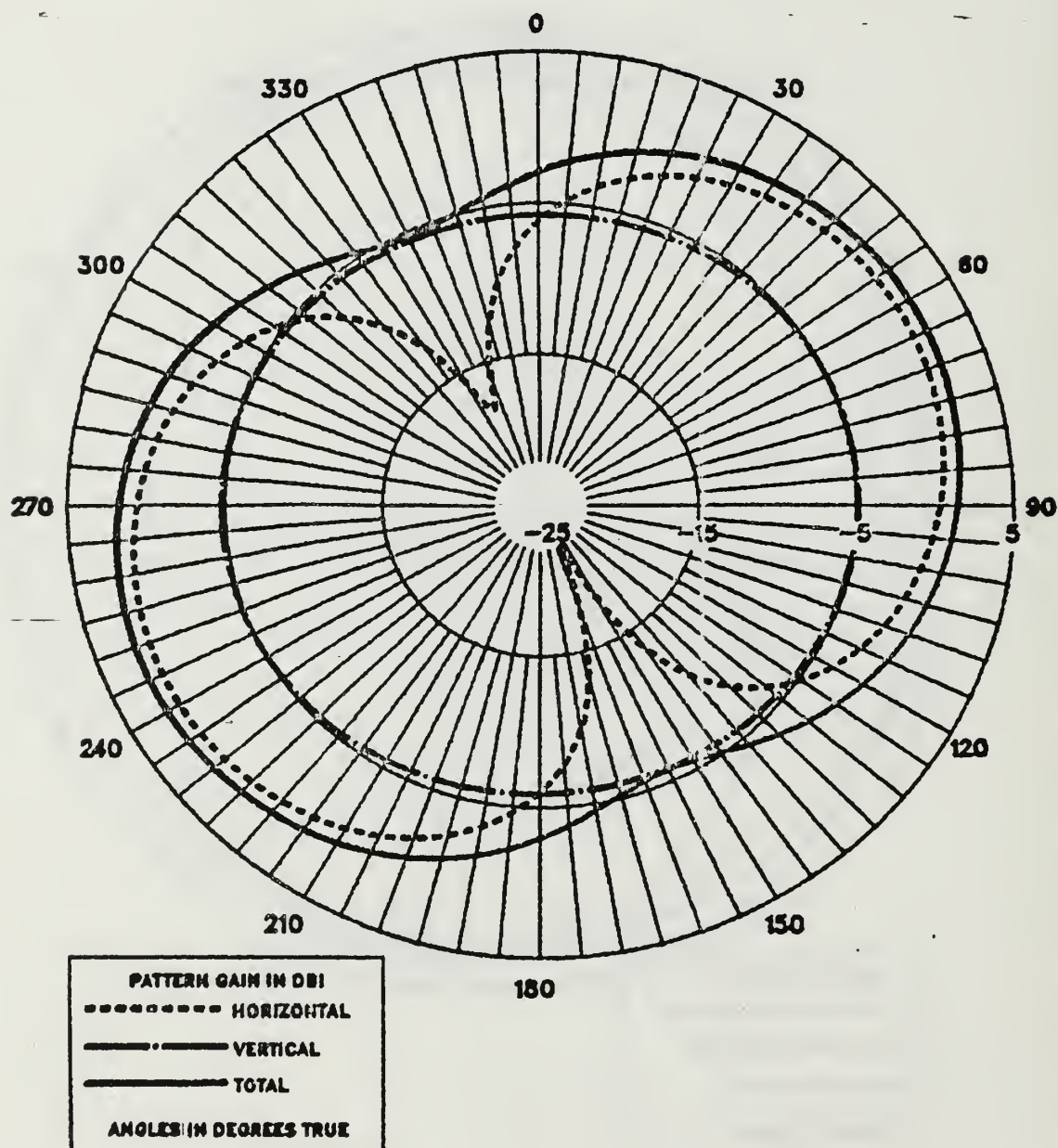
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NAVY 437R-2 ANT, FREE SPACE, VERT CUT, PHI=45



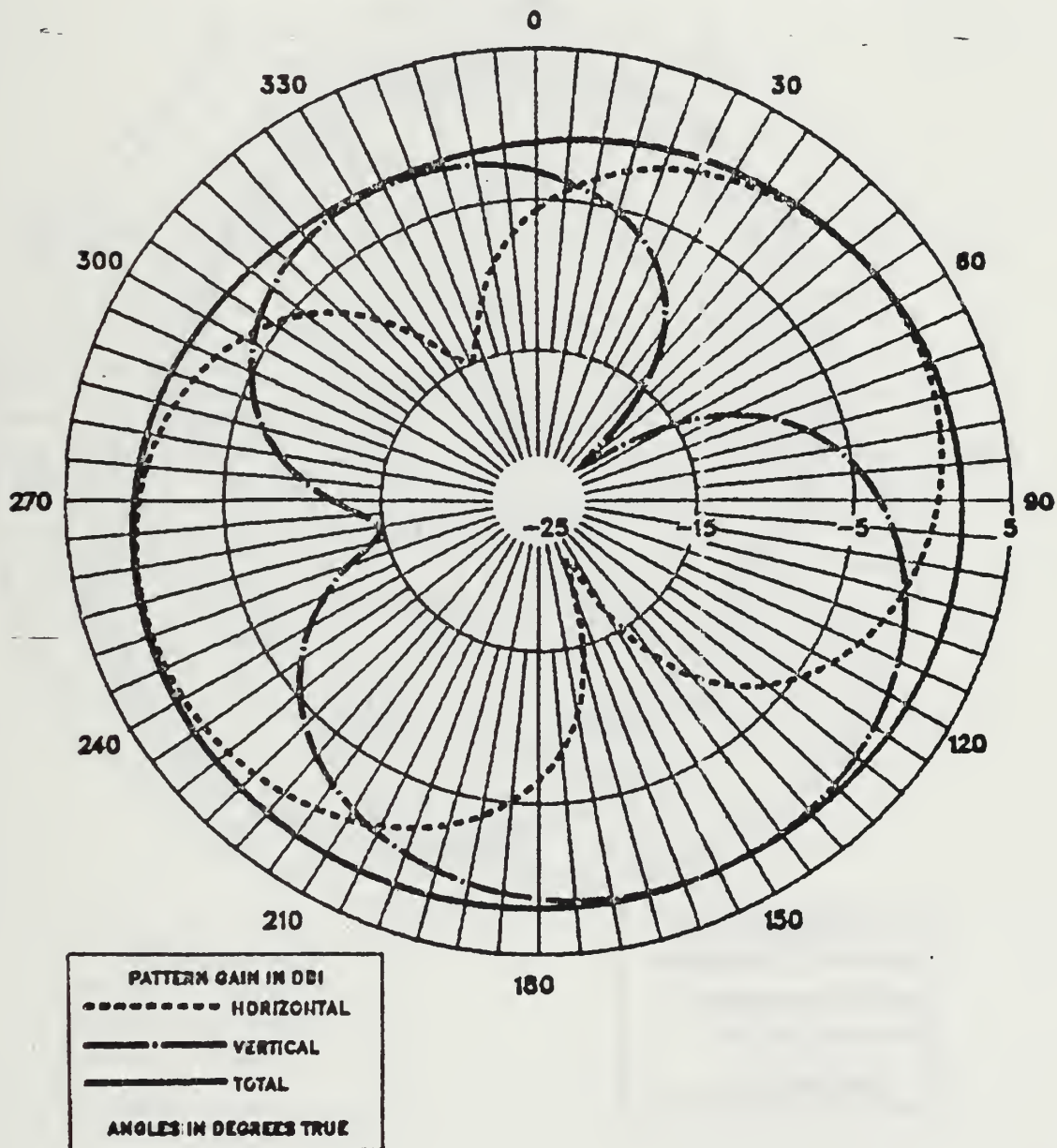
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CG 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=90



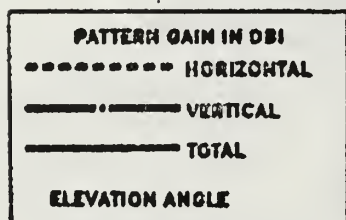
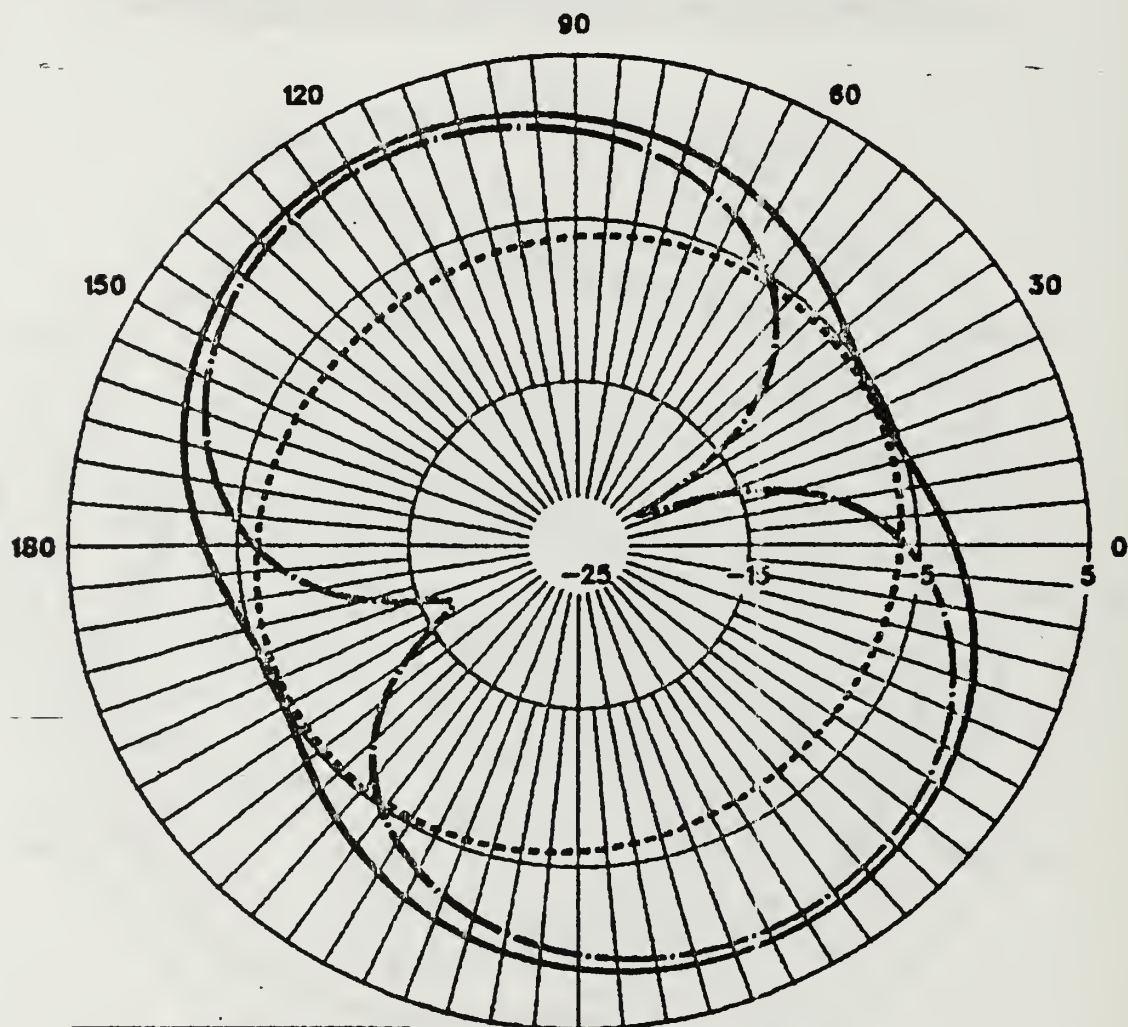
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CG 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=26



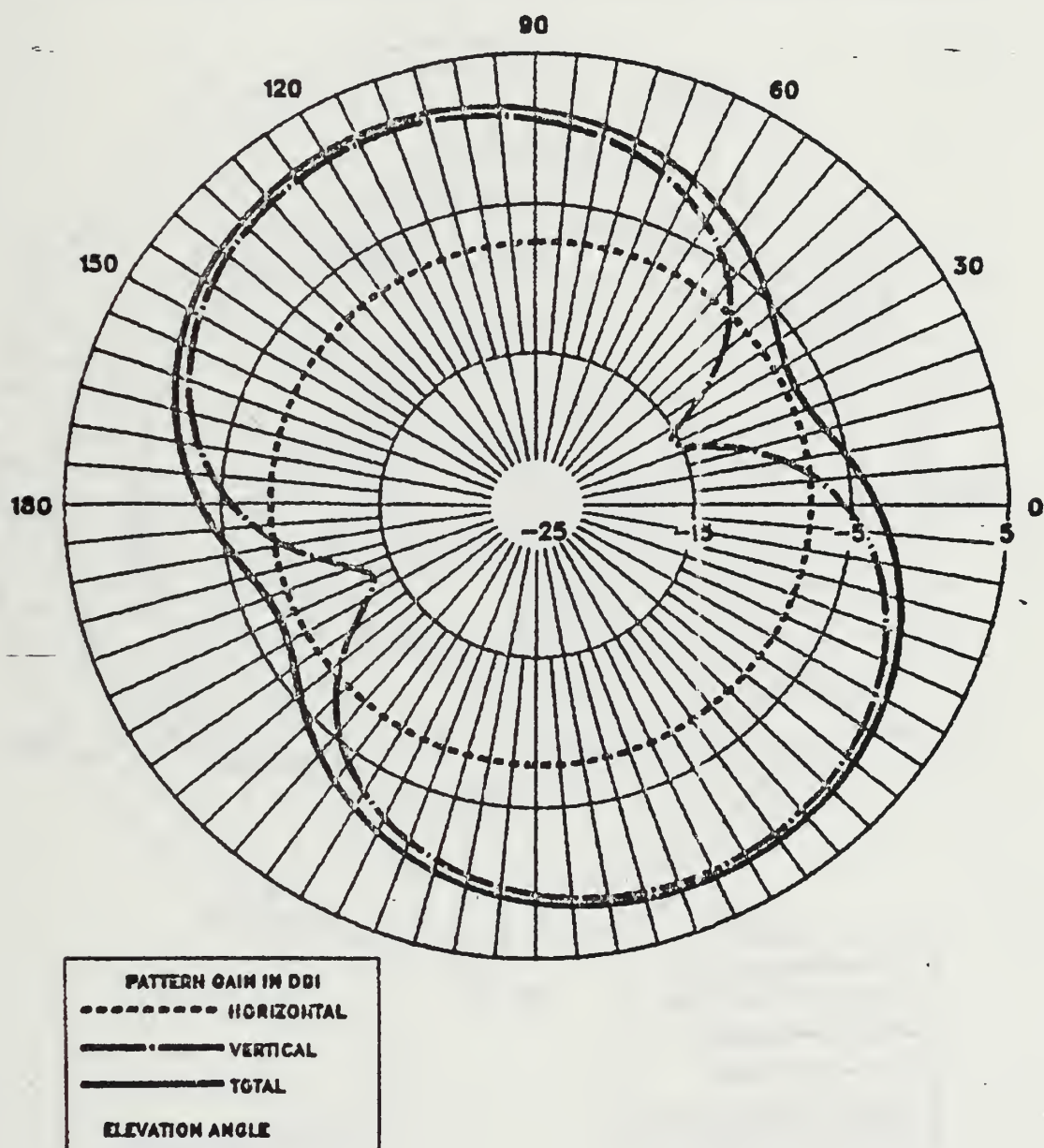
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CG 437R-2 ANT, FREE SPACE, VERT CUT, PHI=0



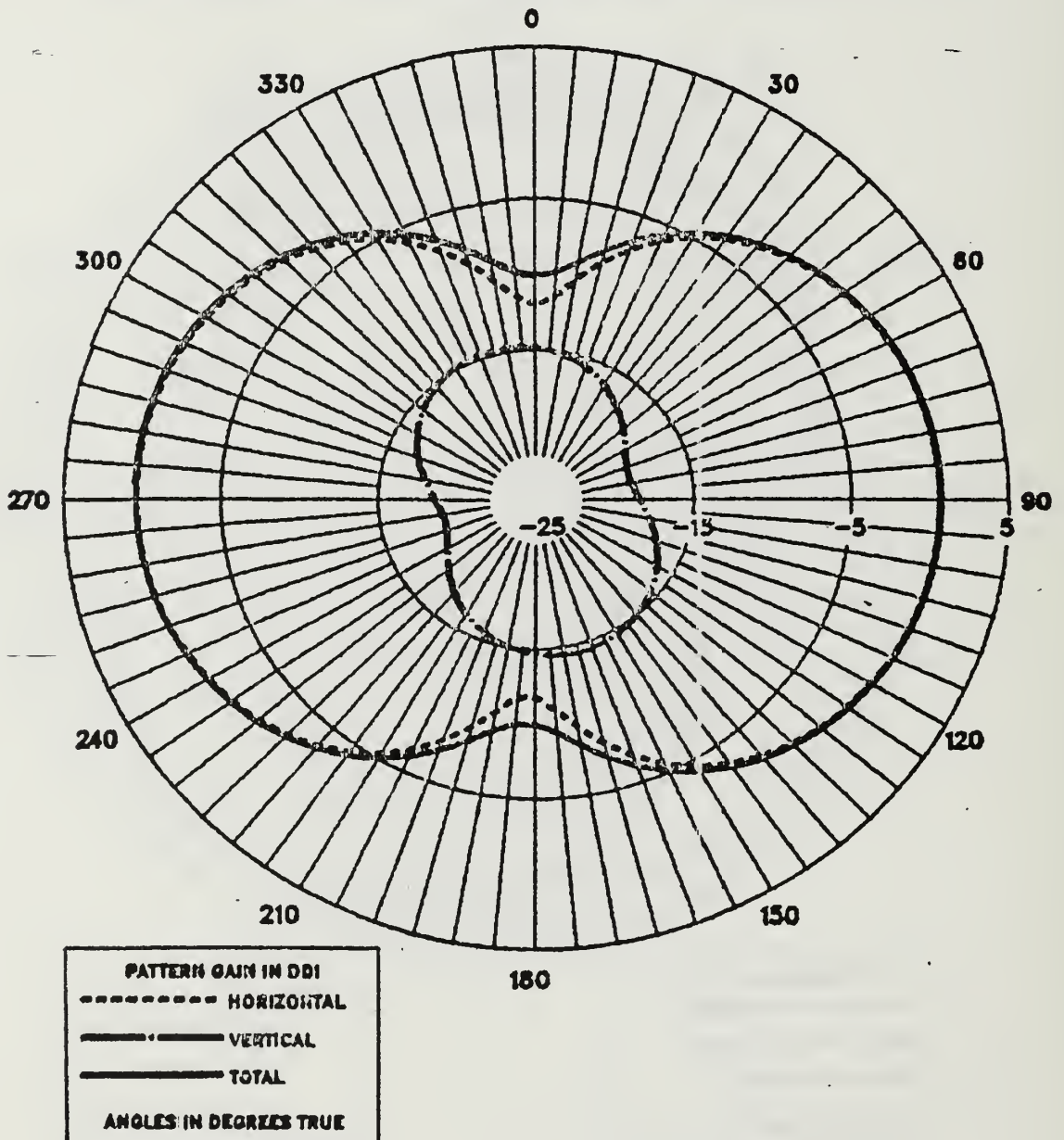
H60 IGUANA DATA RUN AT 4.040MHZ ON 8/18/87

CG 437R-2 ANT, FREE SPACE, VERT CUT, PHI=45



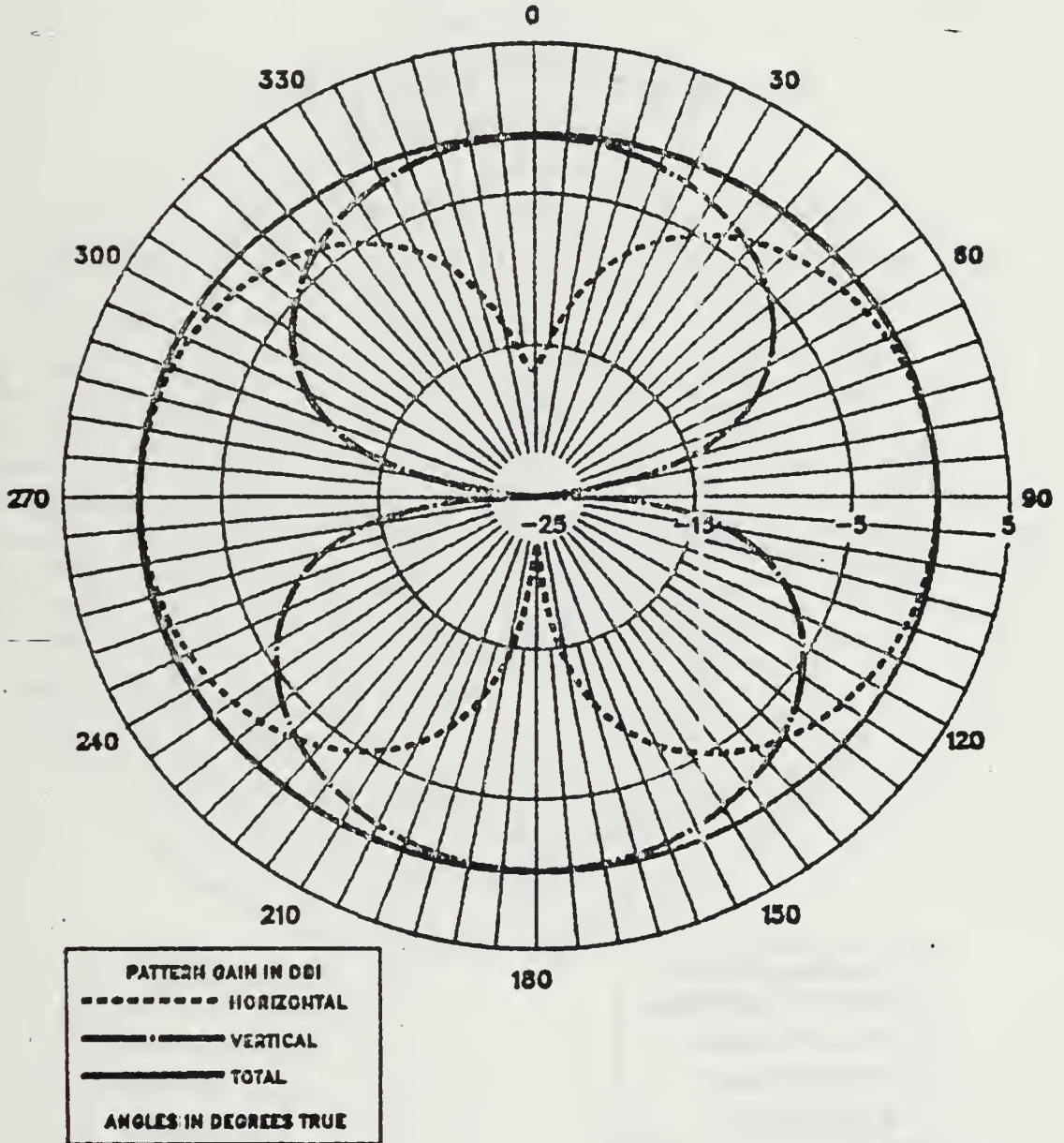
H60 IGUANA DATA RUN AT 4.040MHZ ON 8/18/87

ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CUT, THETA=90



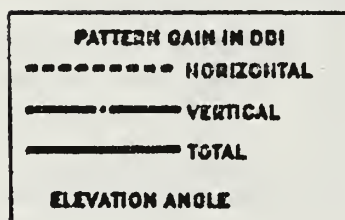
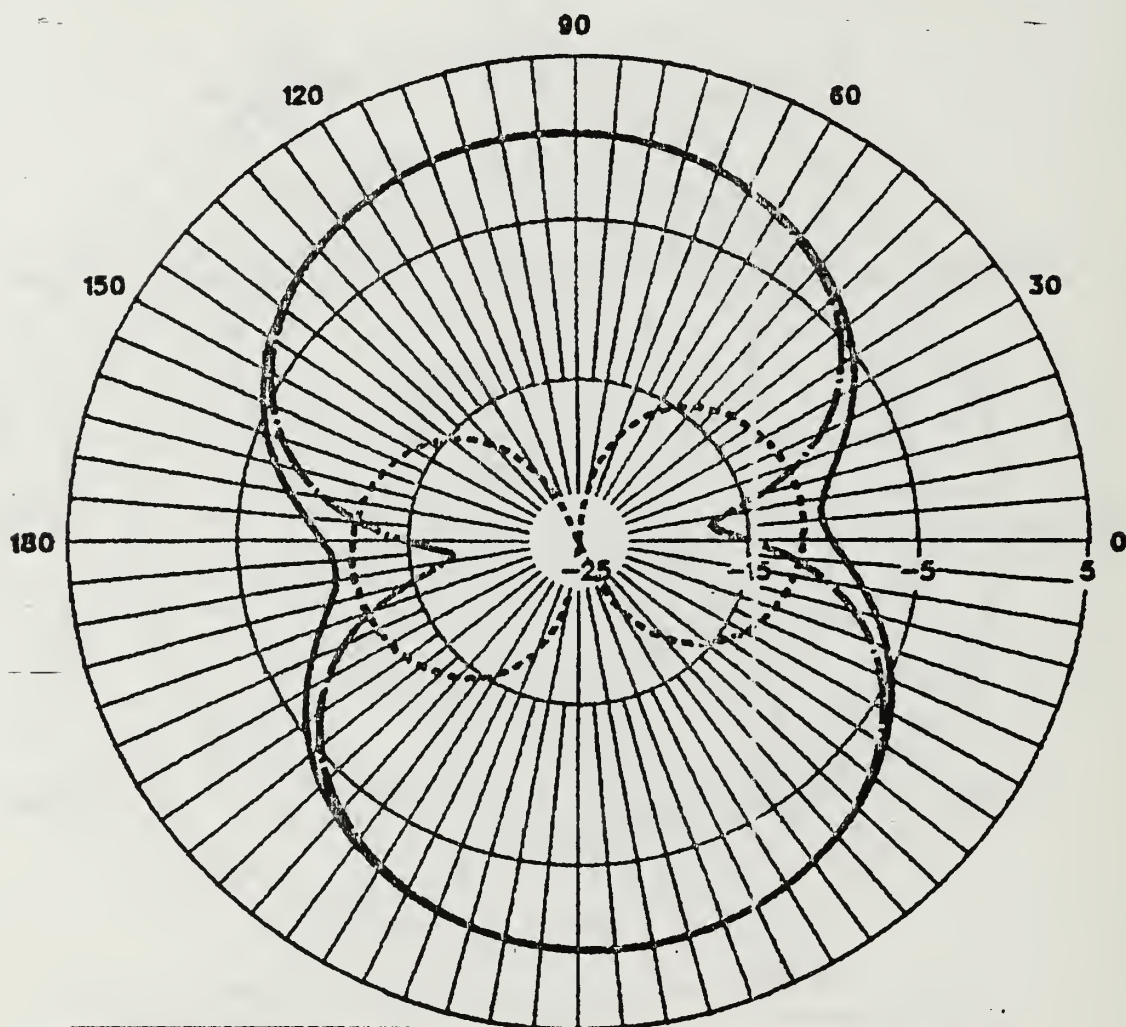
H60 IGUANA DATA RUN AT 4.040MHZ ON 8/18/87

ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CUT, THETA=26



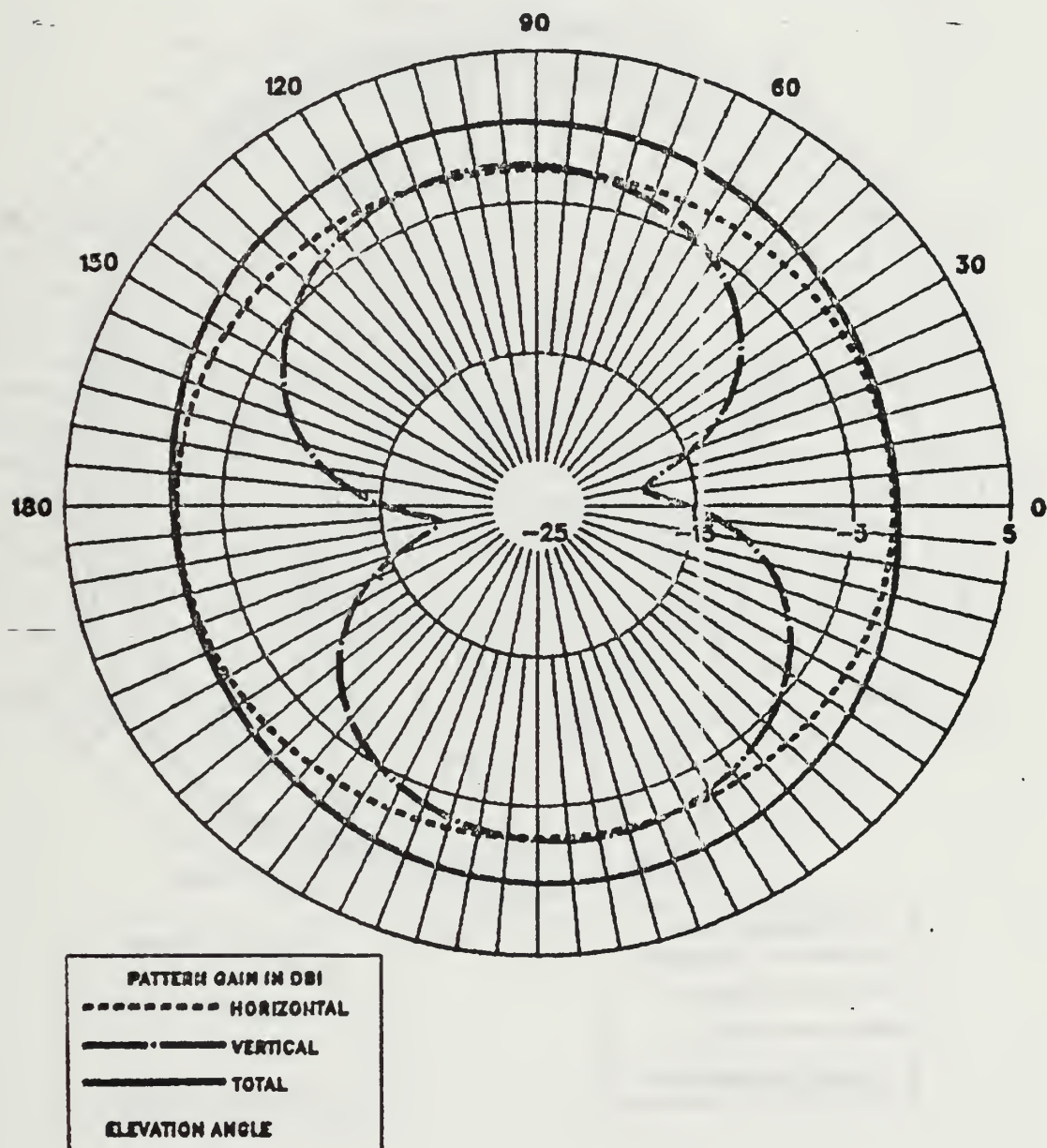
H60 IGUANA DATA RUN AT 4.040MHZ ON 8/18/87

ARMY-TYPE TUBE ANT, FREE SPACE, VERT CUT, PHI=0



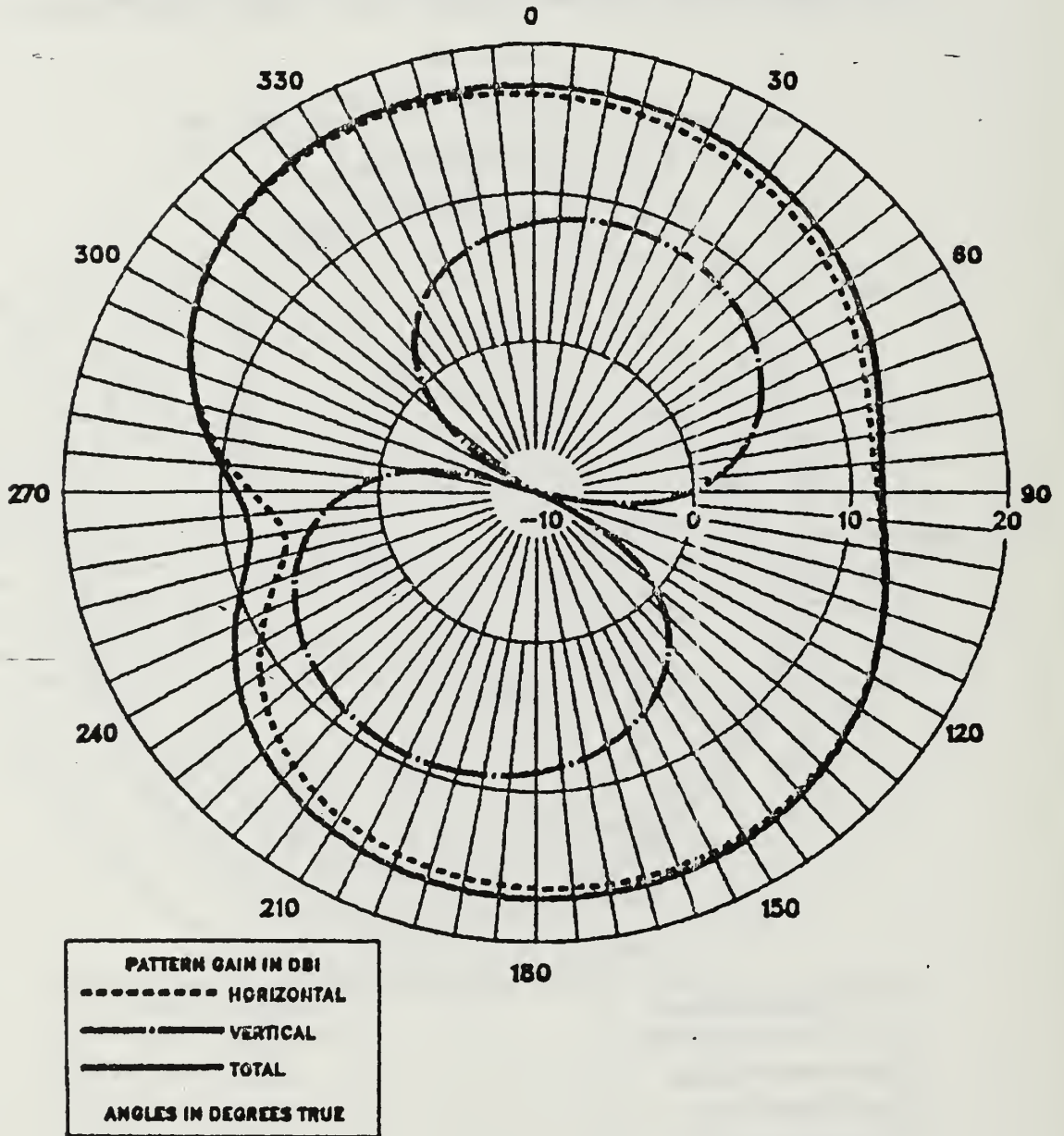
H60 IGUANA DATA RUN AT 4.040MHZ ON 8/18/87

ARMY-TYPE TUBE ANT, FREE SPACE, VERT CUT, PHI=45



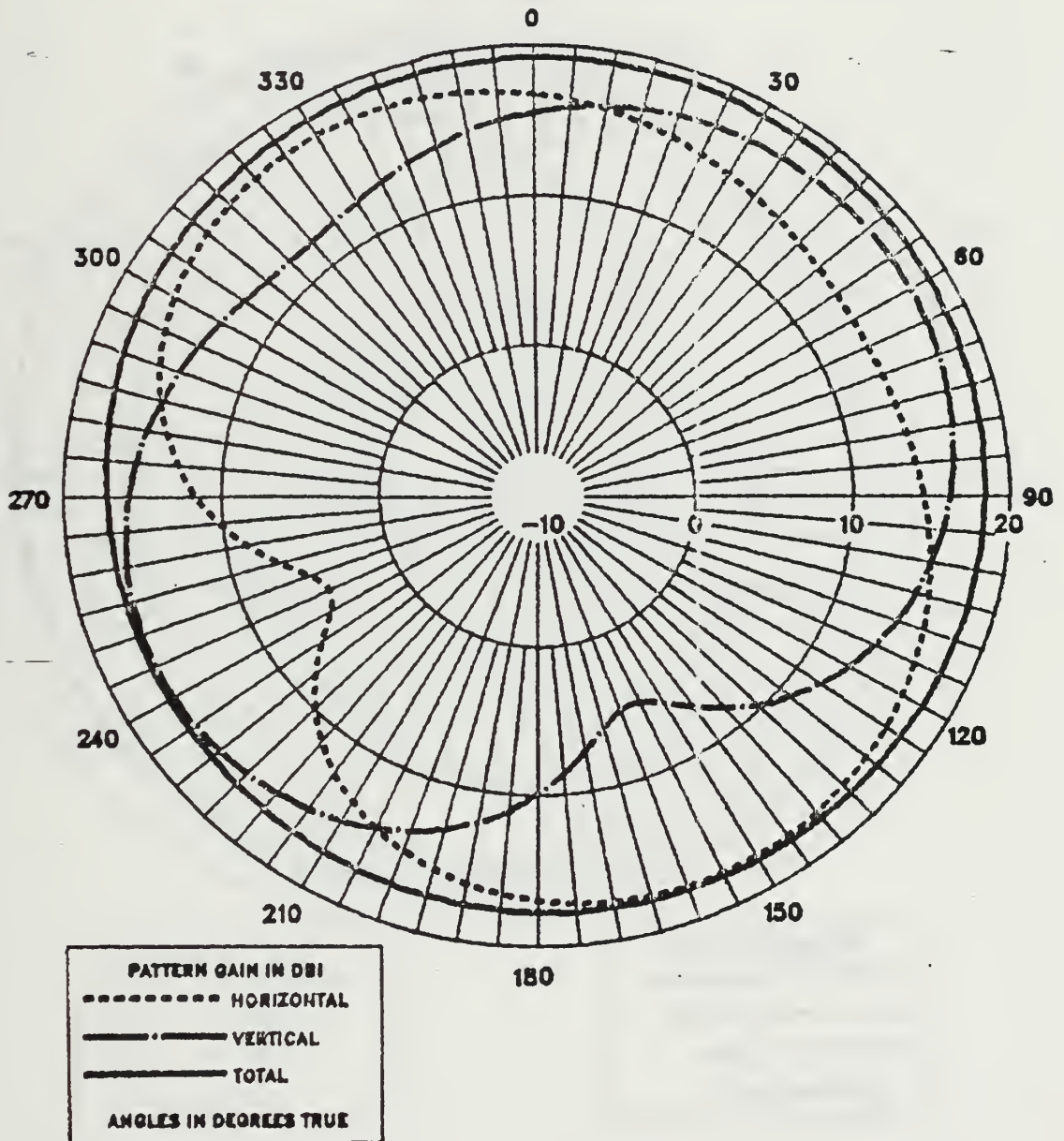
H60 IGUANA DATA RUN AT 5.696MHz ON 8/20/87

LONG-WIRE ANT, FREE SPACE, HORIZ CUT, THETA=90



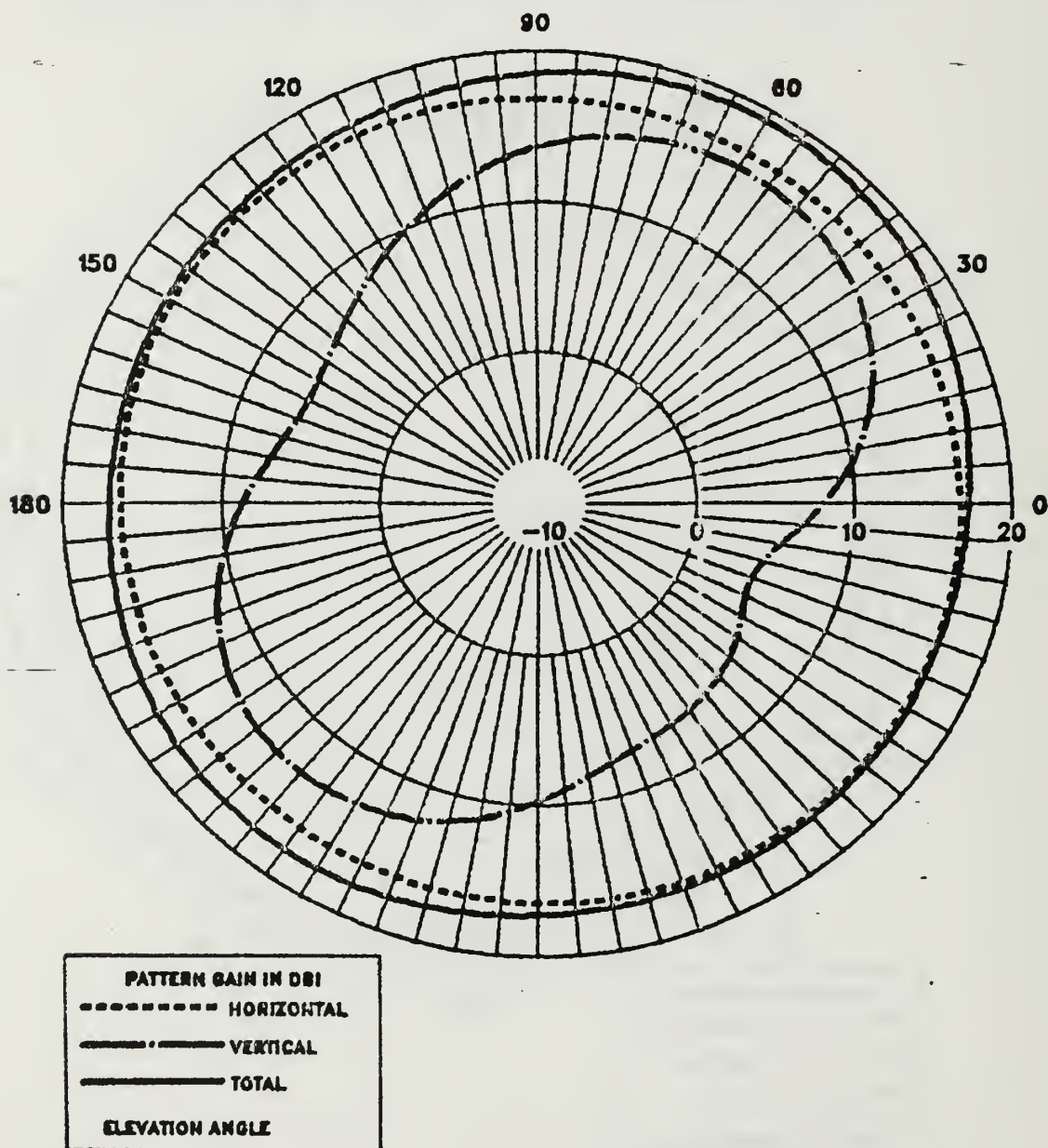
H60 IGUANA DATA RUN AT 5.696MHZ ON 8/20/87

LONG-WIRE ANT, FREE SPACE, HORIZ CUT, THETA=26



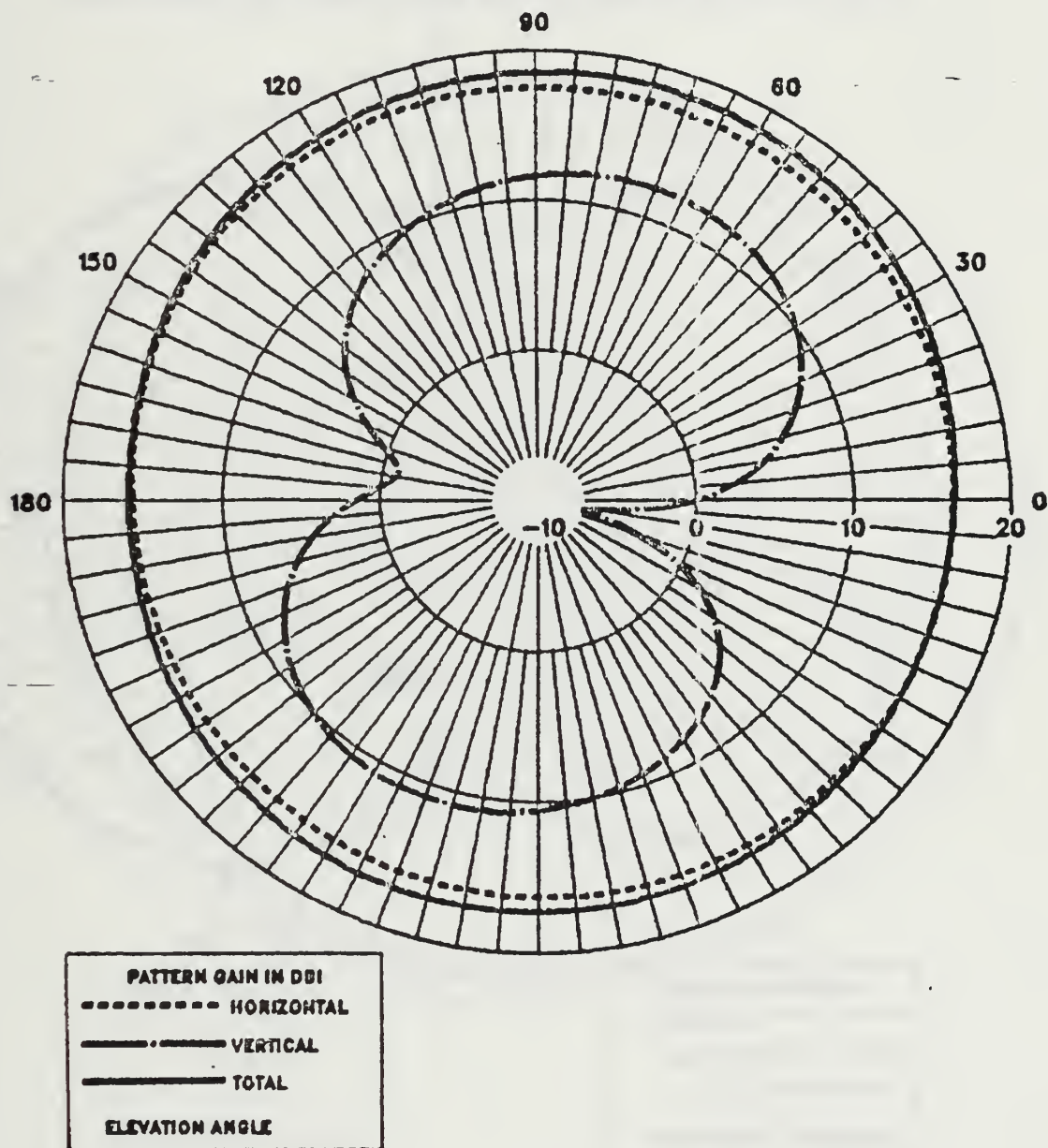
H60 IGUANA DATA RUN AT 5.696MHZ ON 8/20/87

LONG-WIRE ANT, FREE SPACE, VERT CUT, $\Phi=0$



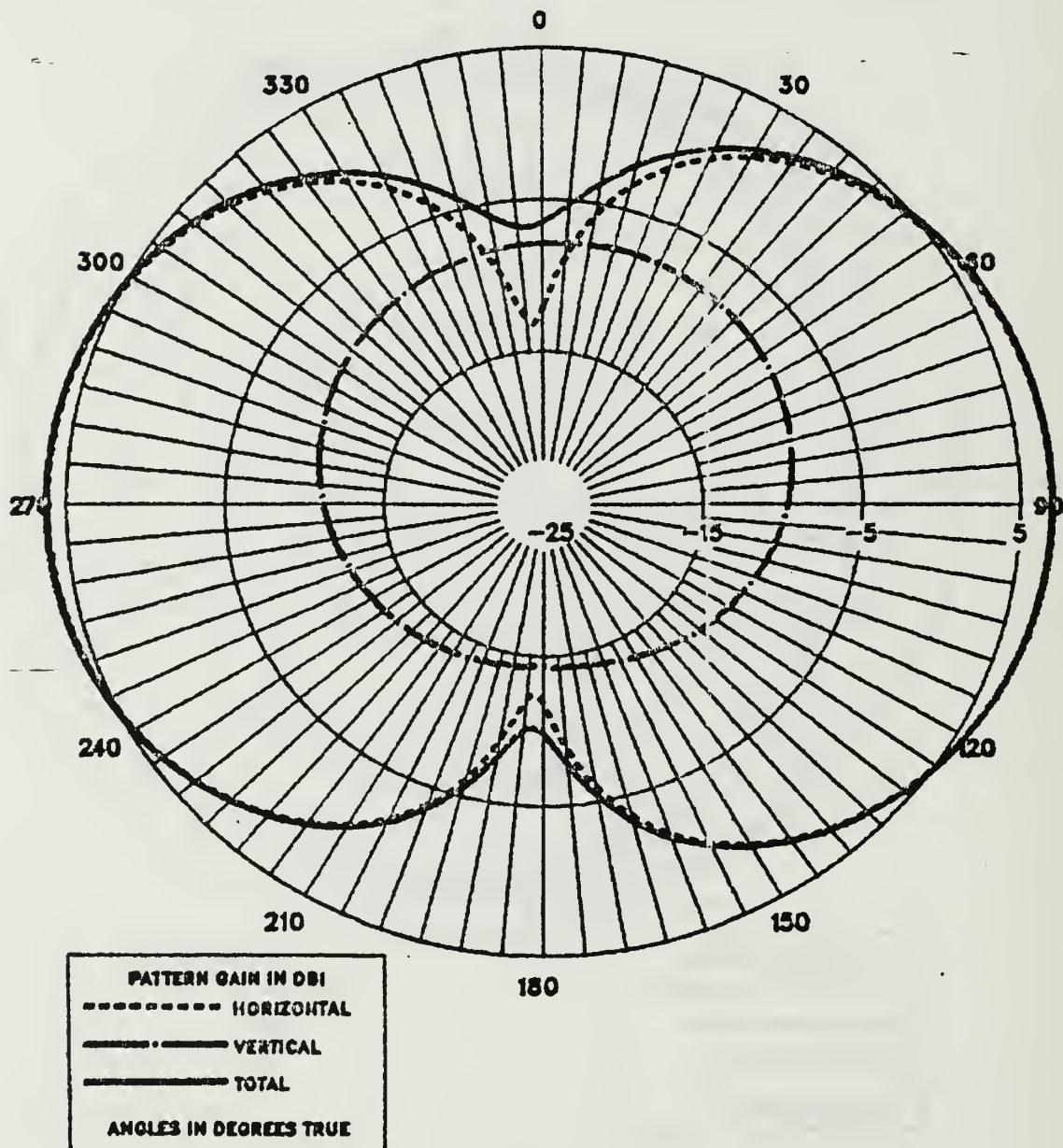
H60 IGUANA DATA RUN AT 5.696MHZ ON 8/20/87

LONG-WIRE ANT, FREE SPACE, VERT CUT, PHI=45



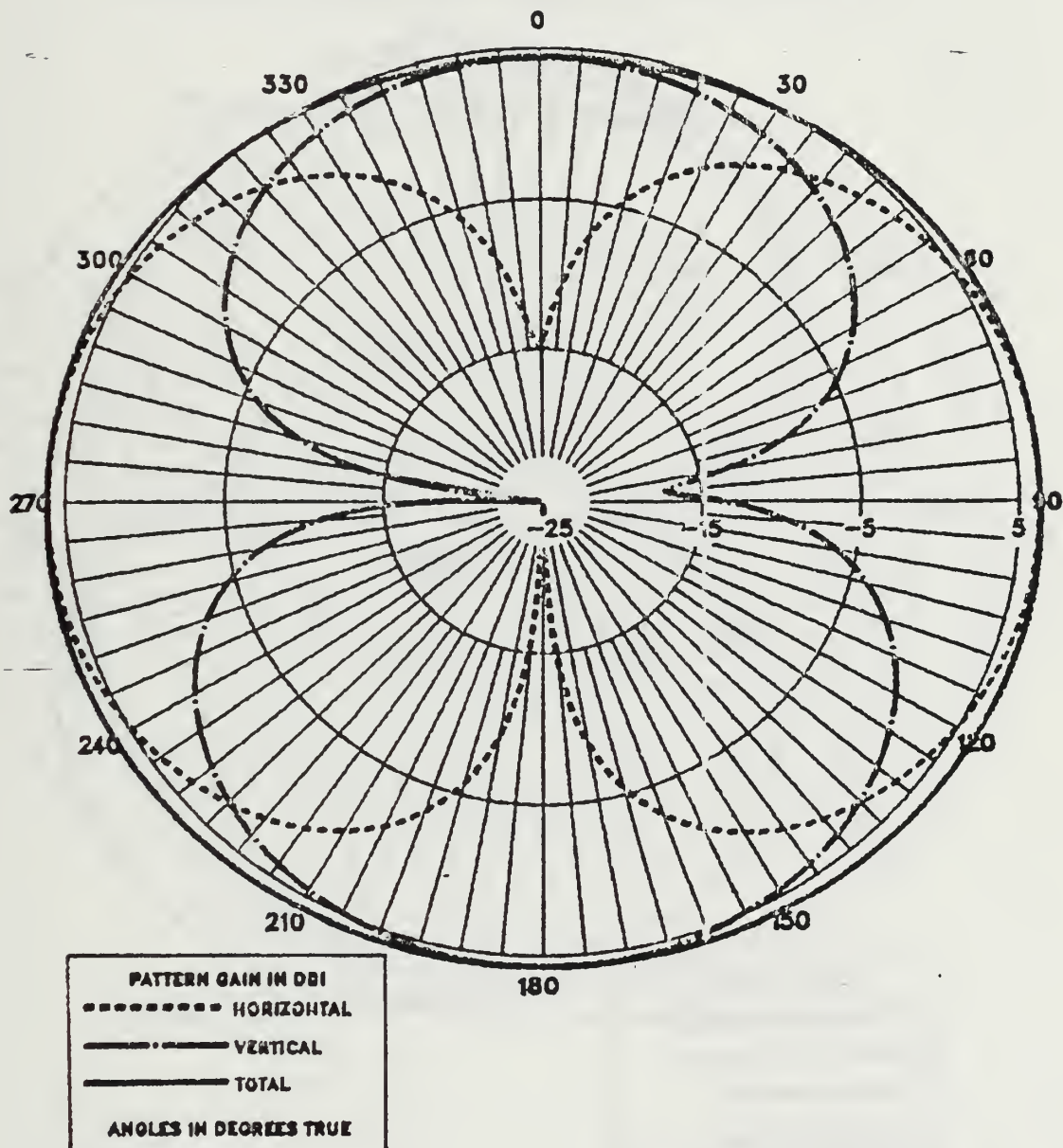
H60 IGUANA DATA RUN AT 5.696MHZ ON 8/20/87

NAVY 437R-2, FREE SPACE, HORIZ CUT, THETA=90



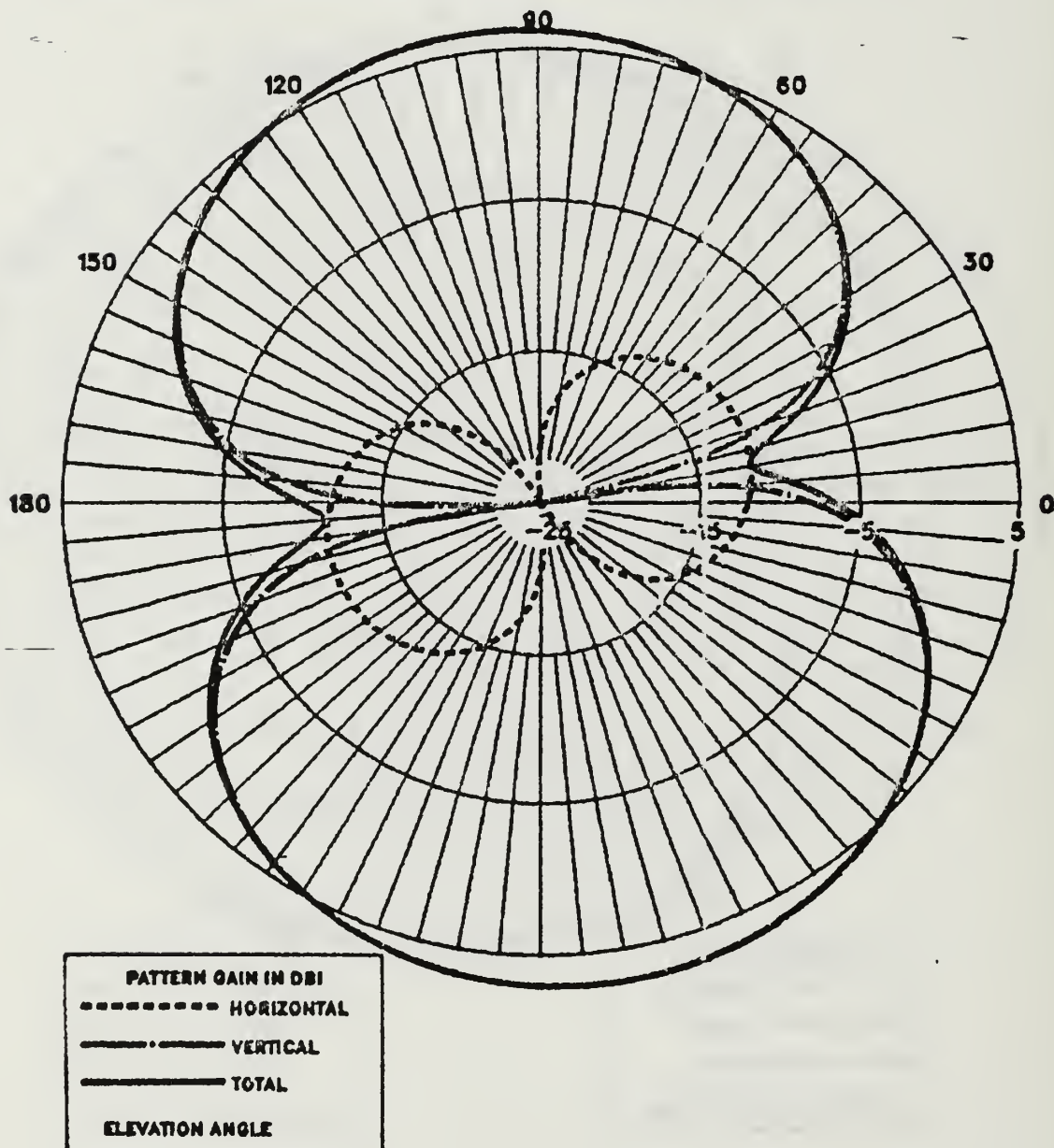
H60 IGUANA DATA RUN AT 5.696MHZ ON 8/20/87

NAVY 437R-2, FREE SPACE, HORIZ CUT, THETA=26

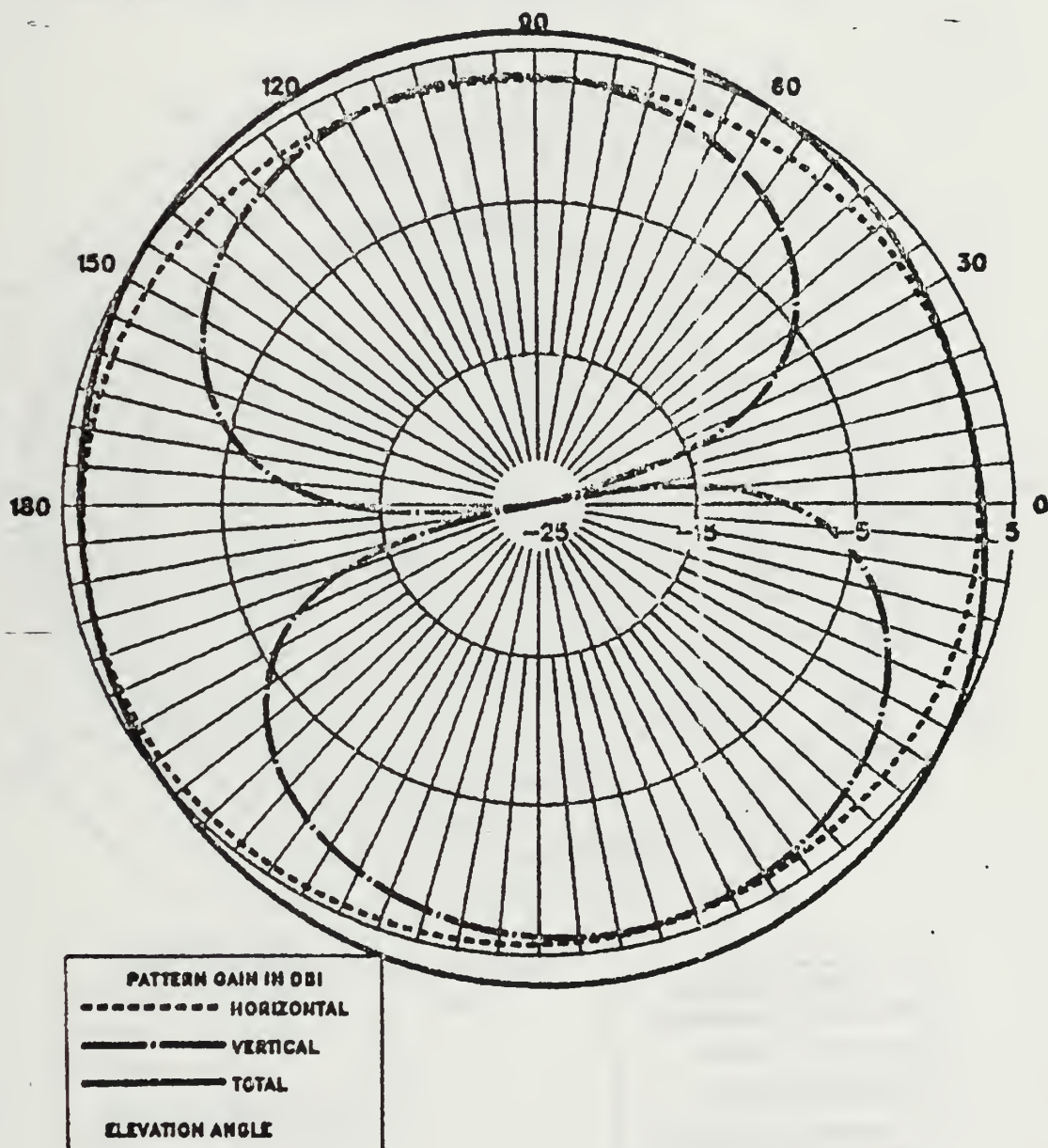


H60 IGUANA DATA RUN AT 5.696MHZ ON 8/20/87

NAVY 437R-2, FREE SPACE, VERT CUT, PHI=0

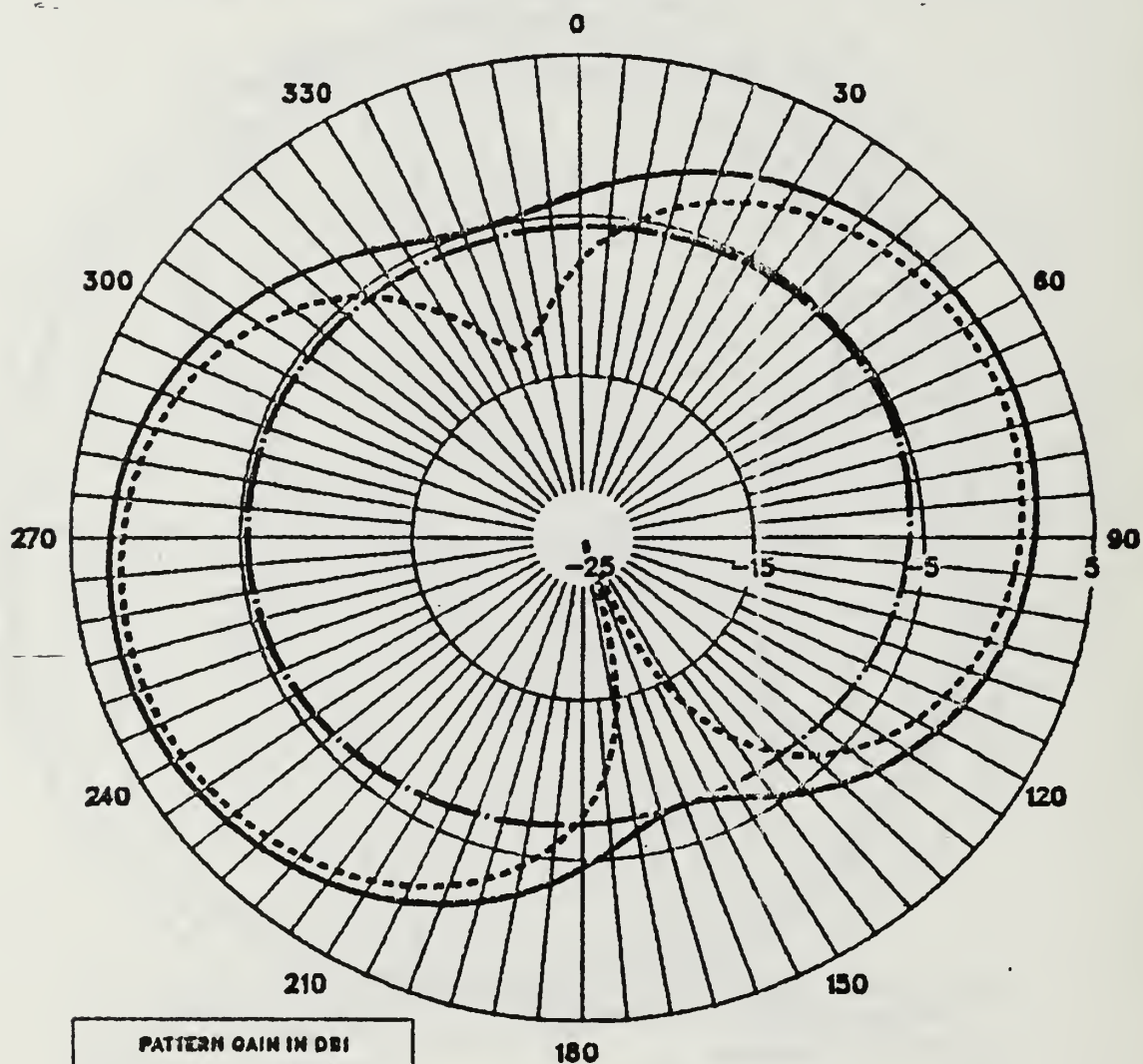


NAVY 437R-2, FREE SPACE, VERT CUT, PHI=45



H60 IGUANA DATA RUN AT 5.696MHZ ON 8/20/87

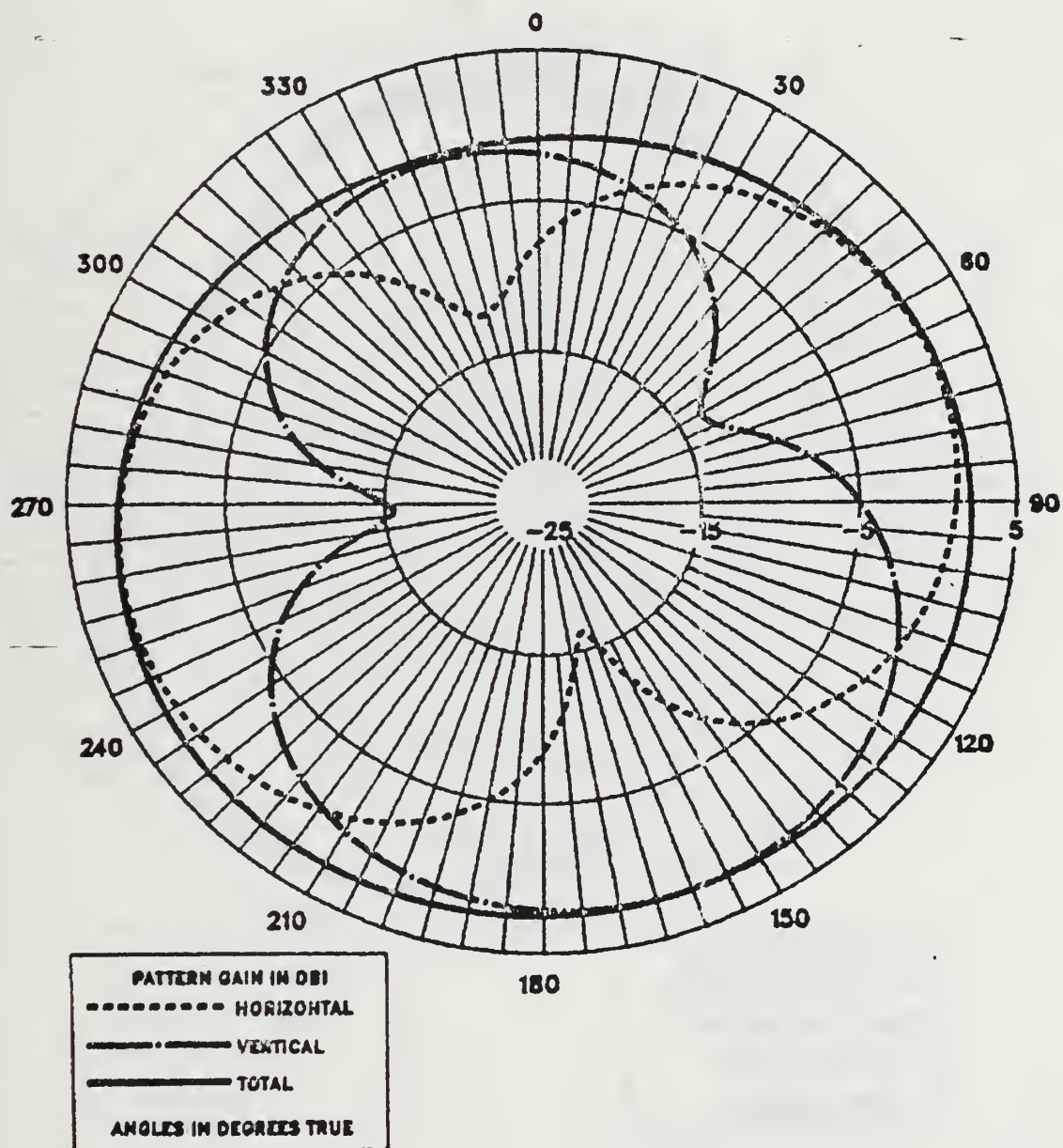
CG 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=90



PATTERN GAIN IN DBI
 ----- HORIZONTAL
 ----- VERTICAL
 ----- TOTAL
ANGLES IN DEGREES TRUE

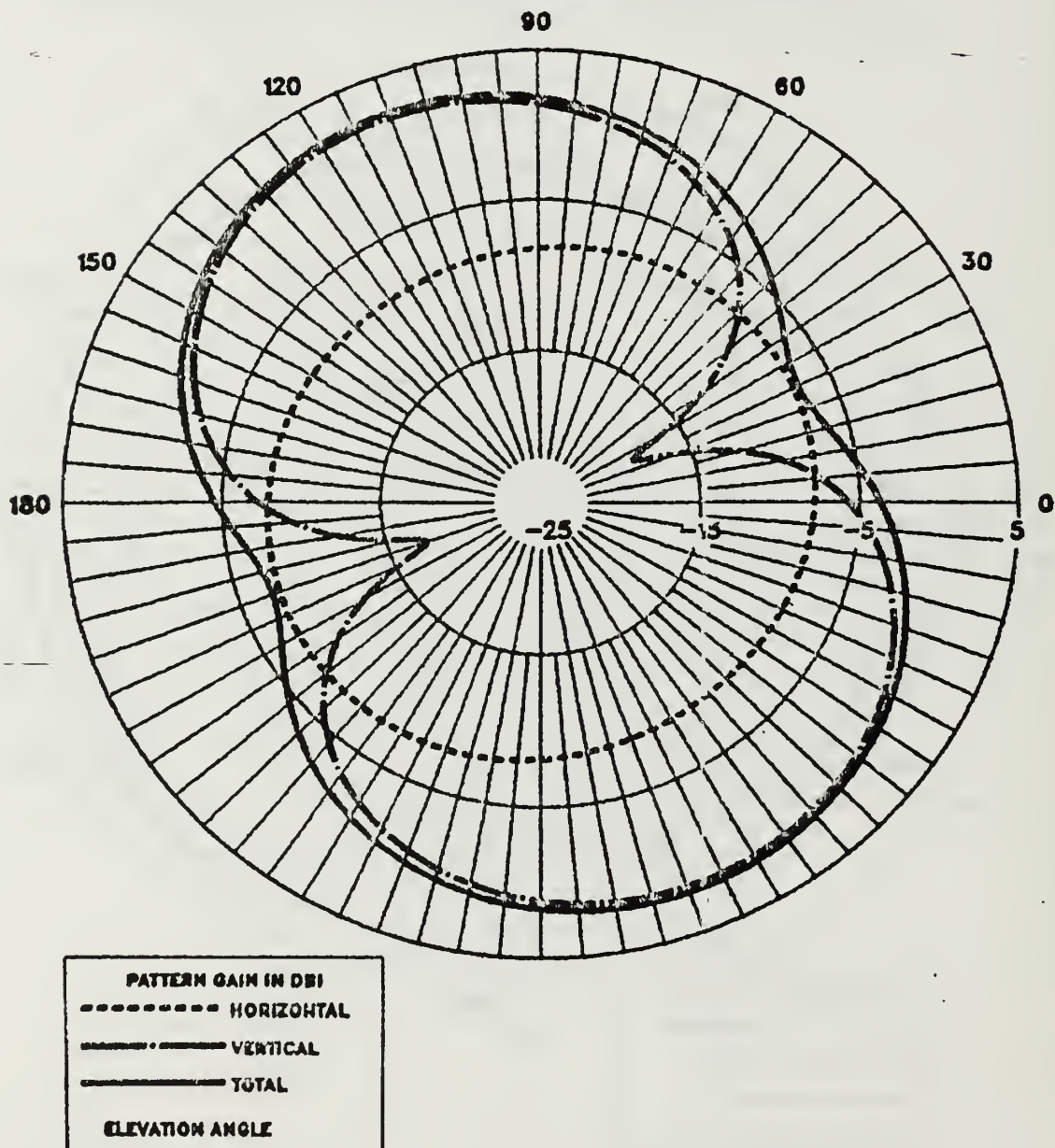
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CG 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=26



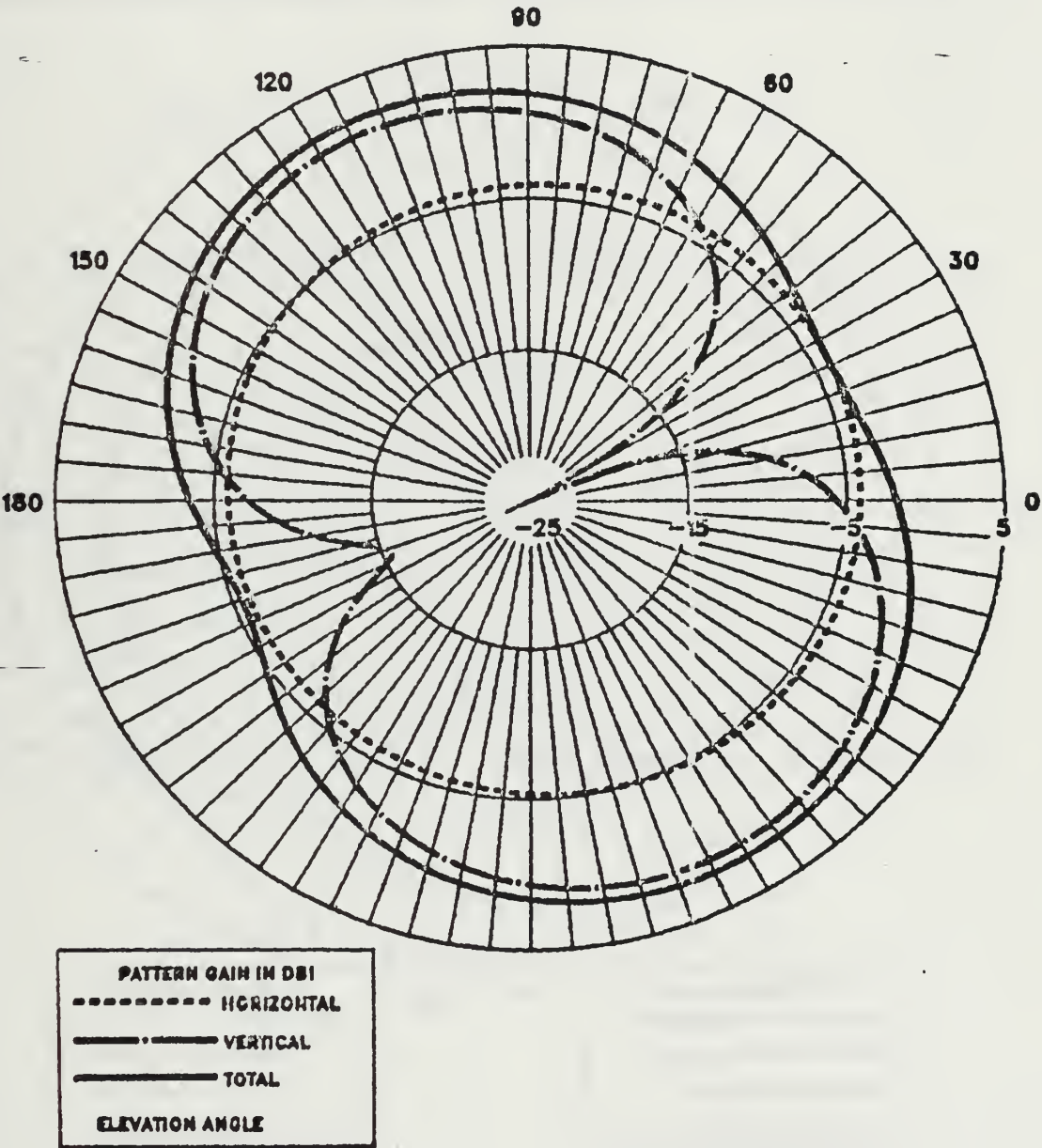
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CG 437R-2 ANT, FREE SPACE, VERT CUT, PHI=0



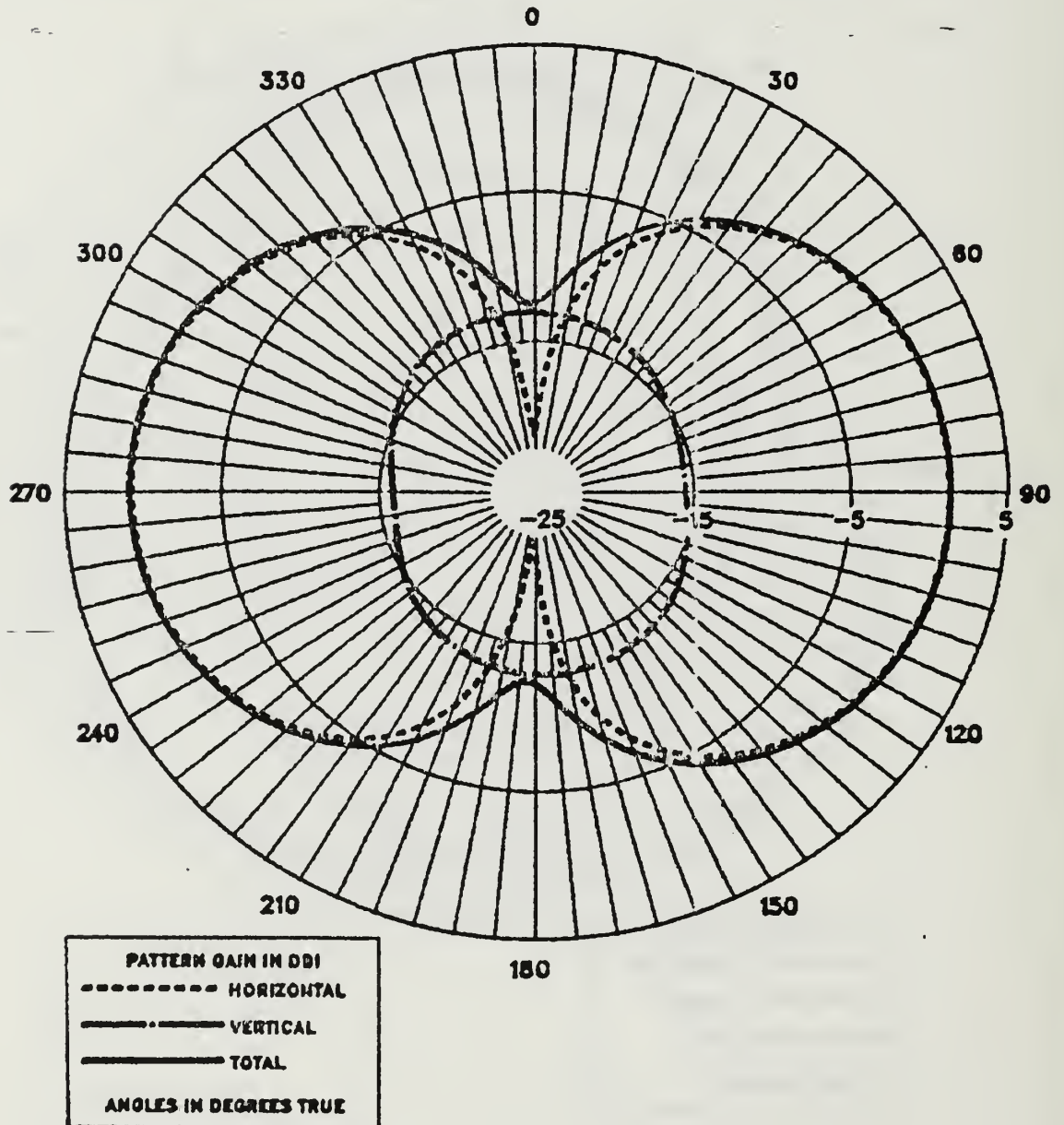
H60 IGUANA DATA RUN AT 5.696MHZ ON 8/20/87

CG 437R-2 ANT, FREE SPACE, VERT CUT, PHI=45



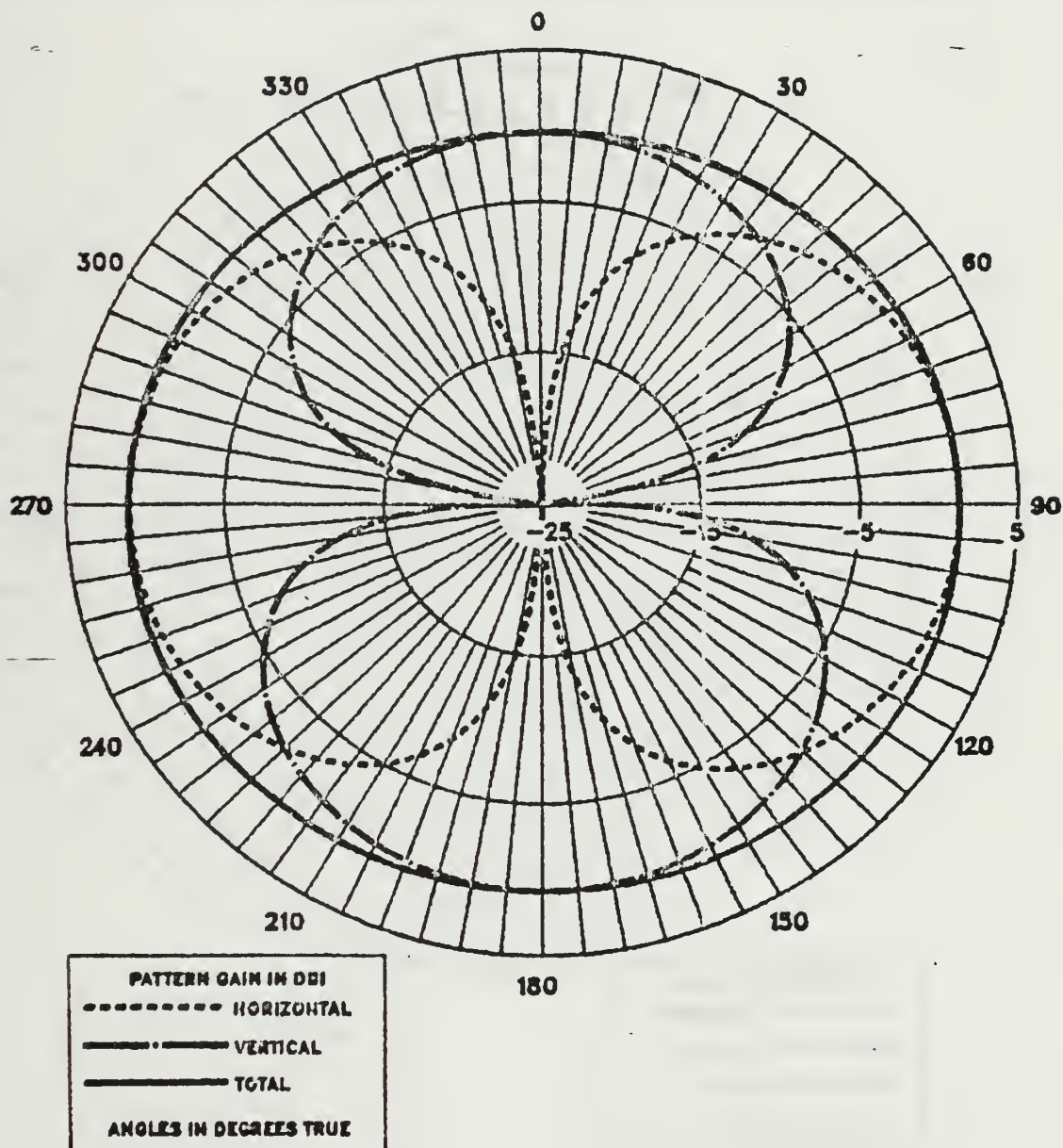
H60 IGUANA DATA RUN AT 5.696MHZ ON 8/20/87

ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CUT, THETA=90



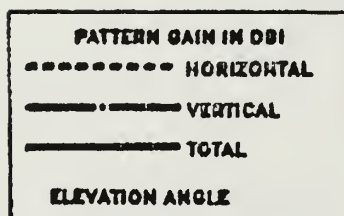
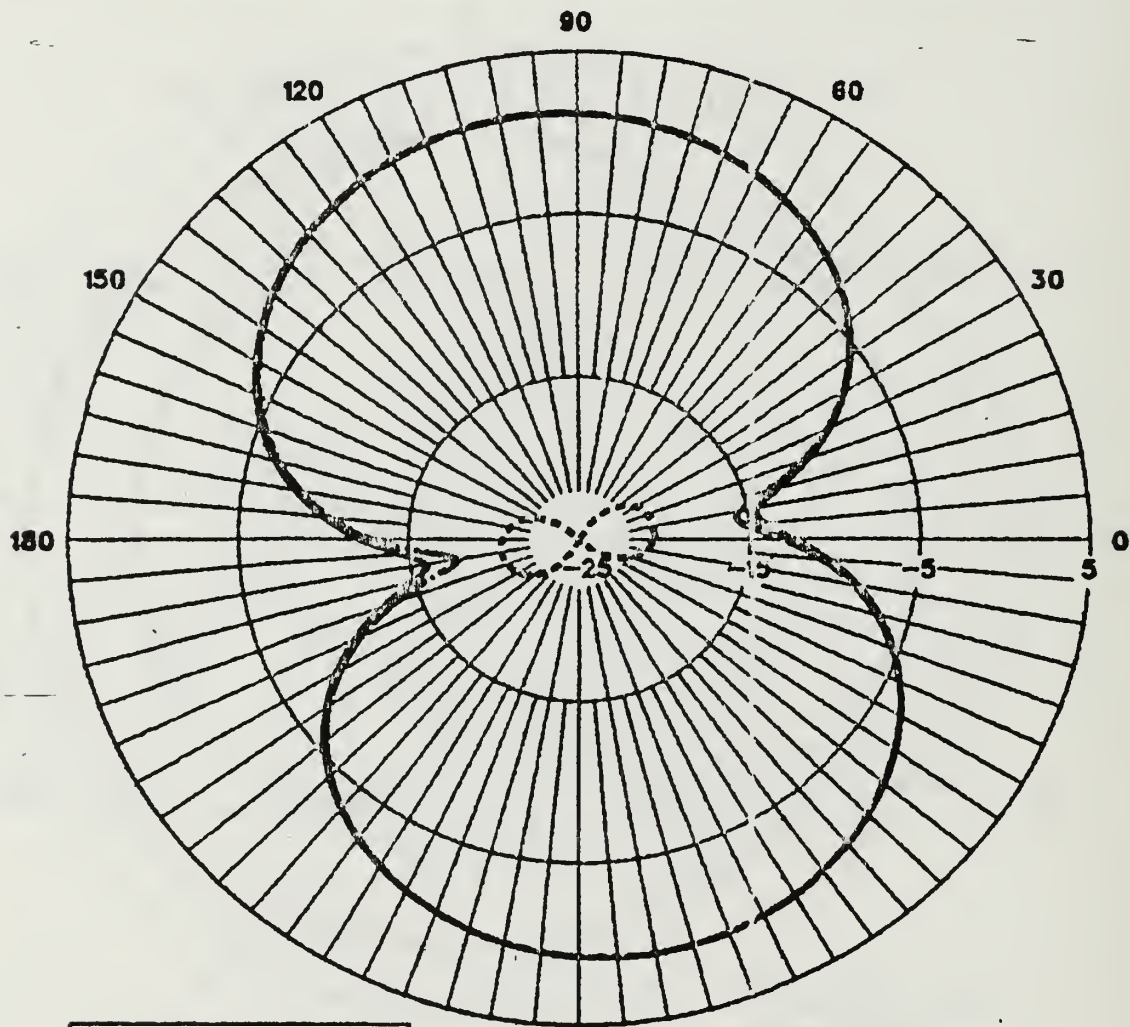
H60 IGUANA DATA RUN AT 5.696MHZ ON 8/20/87

ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CUT, THETA=26



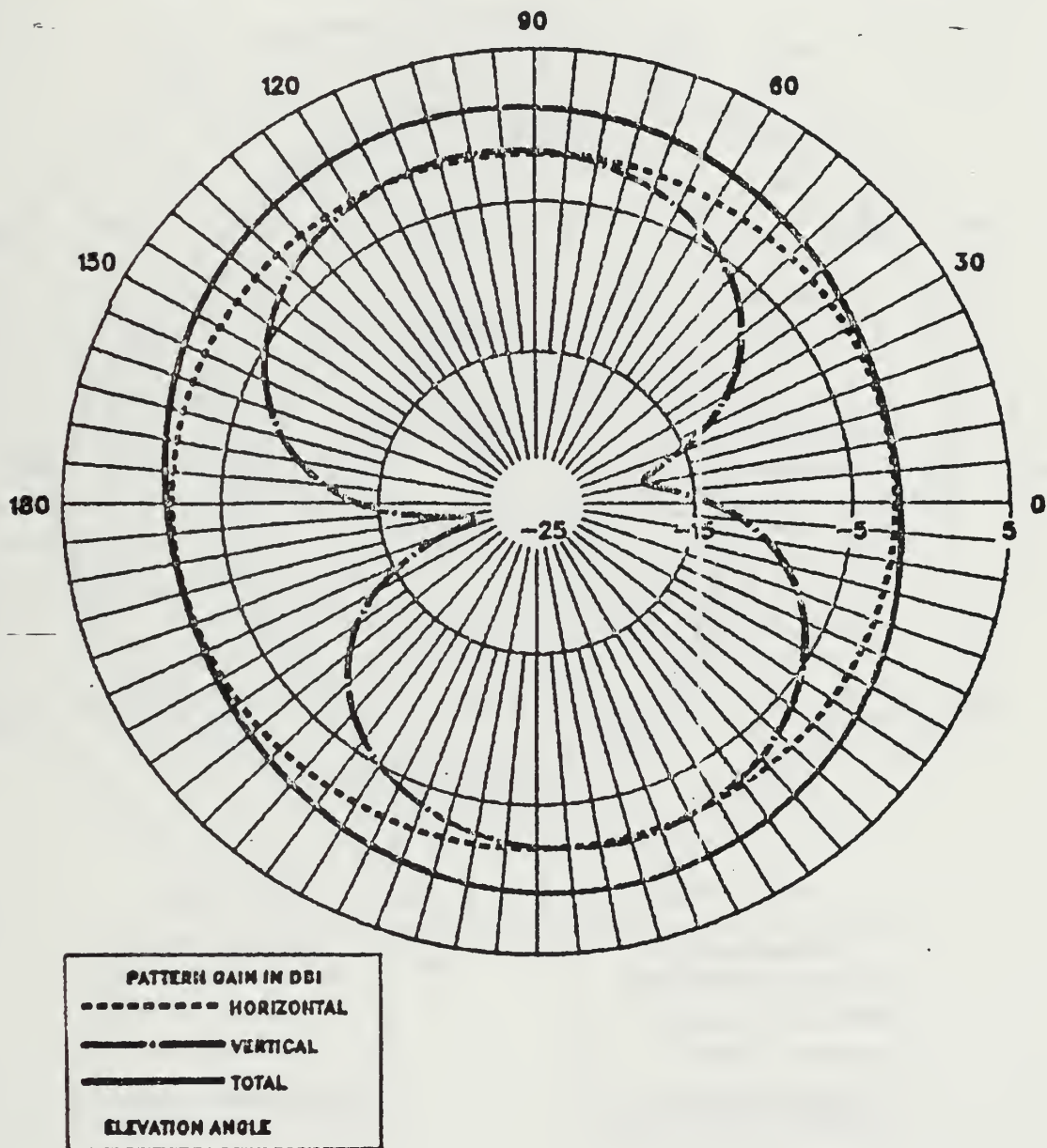
H60 IGUANA DATA RUN AT 5.696MHZ ON 8/20/87

ARMY-TYPE TUBE ANT, FREE SPACE, VERT CUT, $\Phi=0$



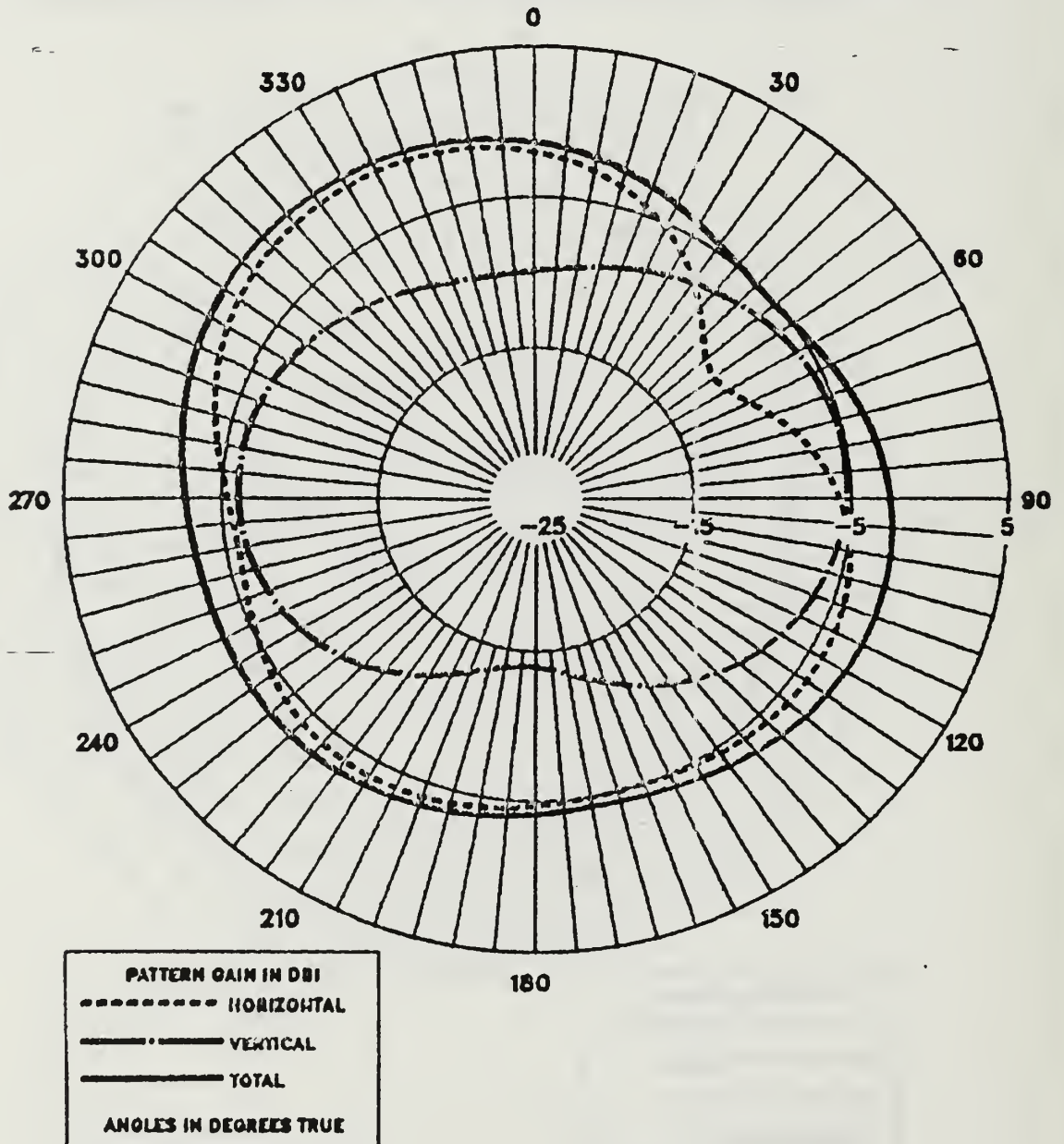
H60 IGUANA DATA RUN AT 5.696MHZ ON 8/20/87

ARMY-TYPE TUBE ANT, FREE SPACE, VERT CUT, PHI=45



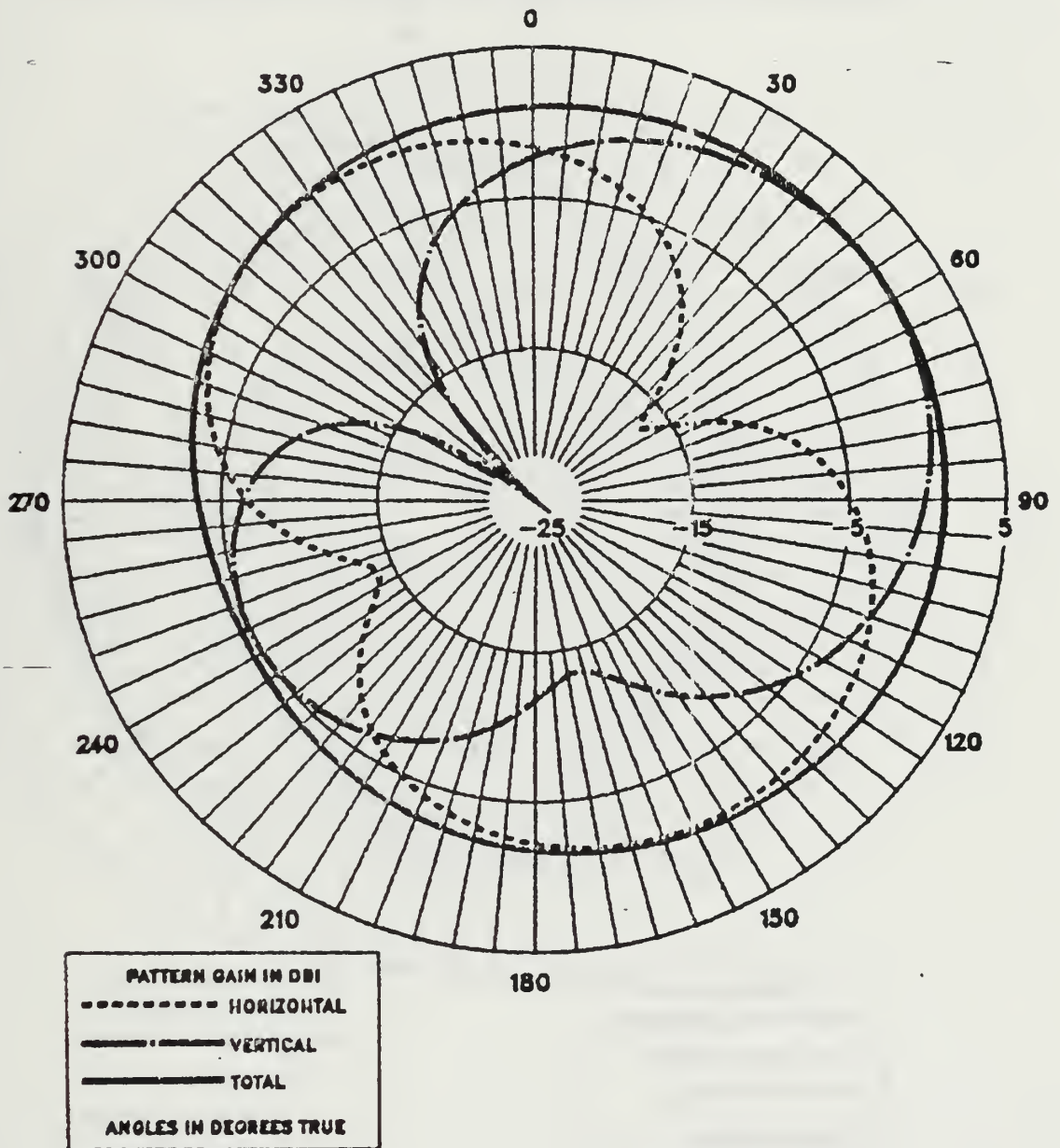
H60 IGUANA DATA RUN AT 7.645MHZ ON 8/21/87

LONG-WIRE ANT, FREE SPACE, HORIZ CUT, THETA=90



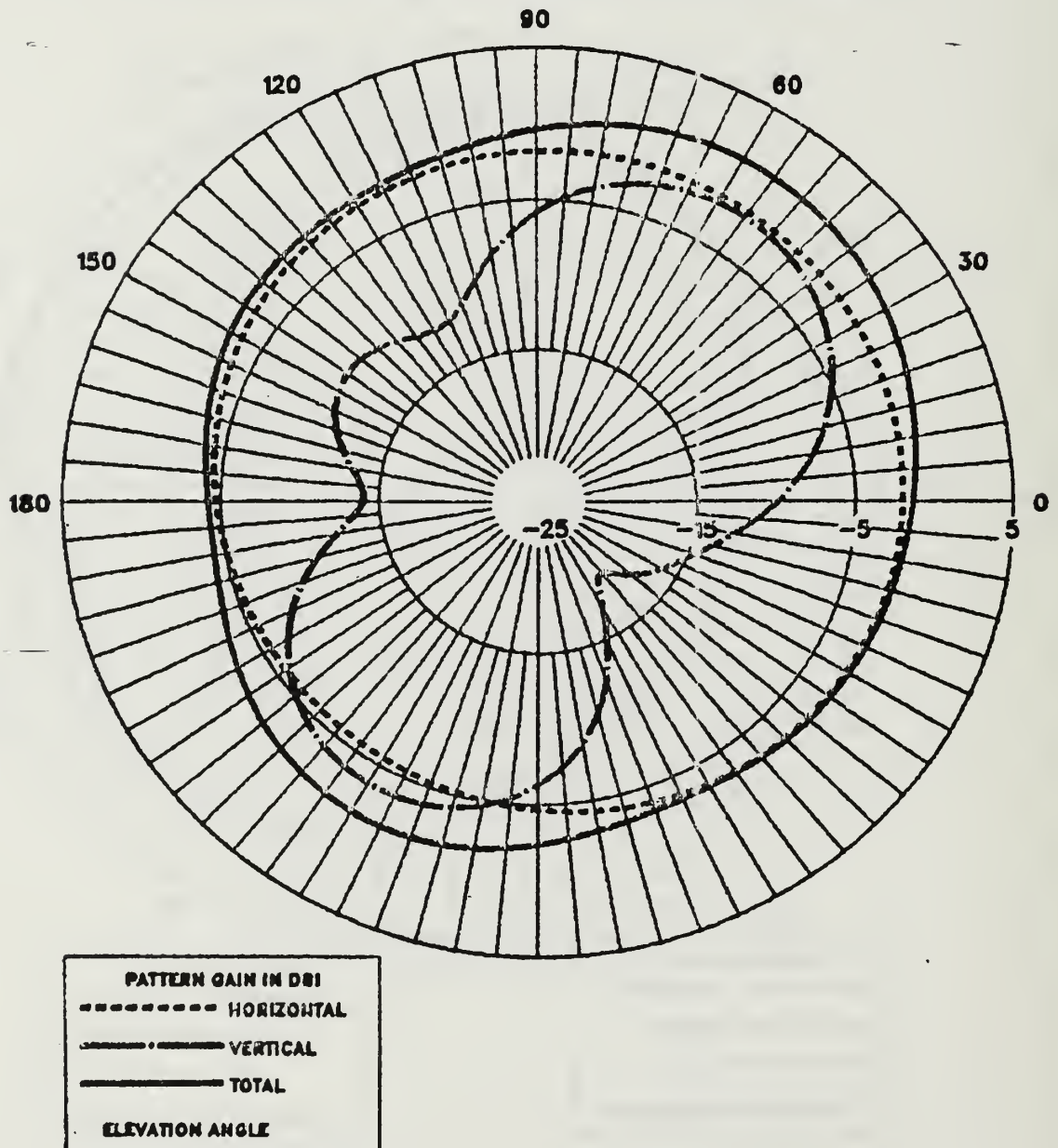
H60 IGUANA DATA RUN AT 7.645MHZ ON 8/21/87

LONG-WIRE ANT, FREE SPACE, HORIZ CUT, THETA=26



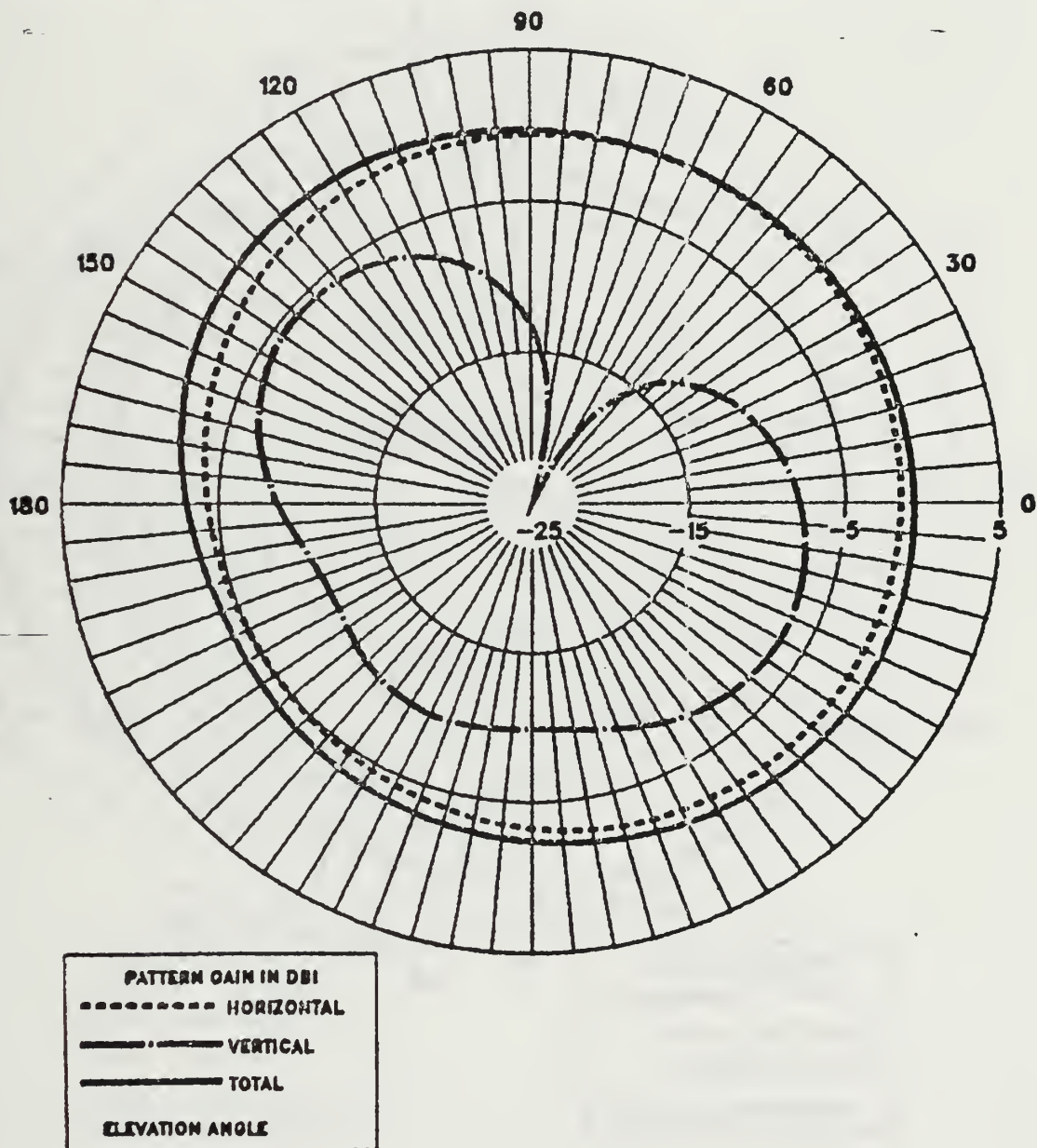
H60 IGUANA DATA RUN AT 7.645MHZ ON 8/21/87

LONG-WIRE ANT, FREE SPACE, VERT CUT, PHI=0



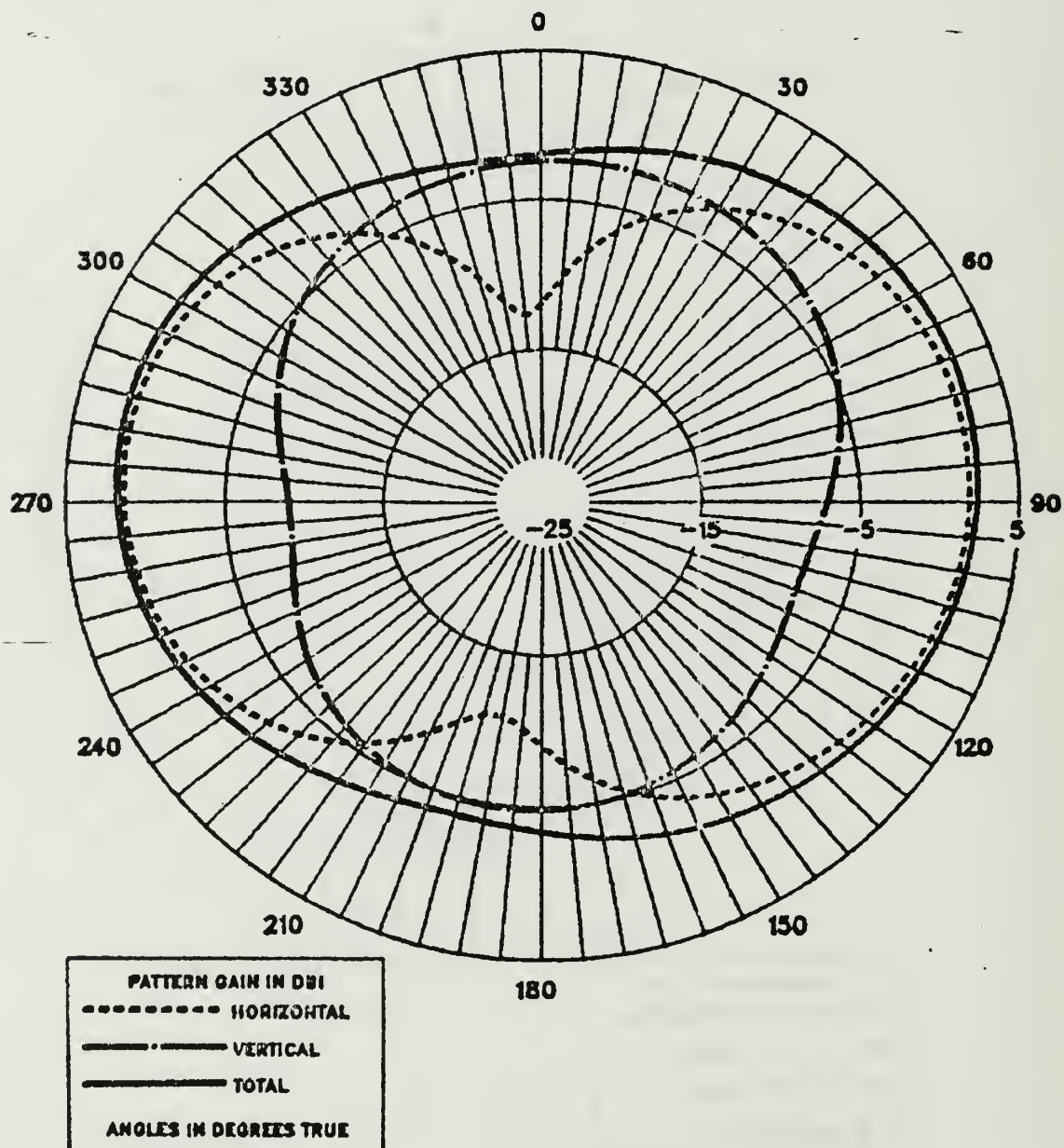
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LONG-WIRE ANT, FREE SPACE, VERT CUT, PHI=45



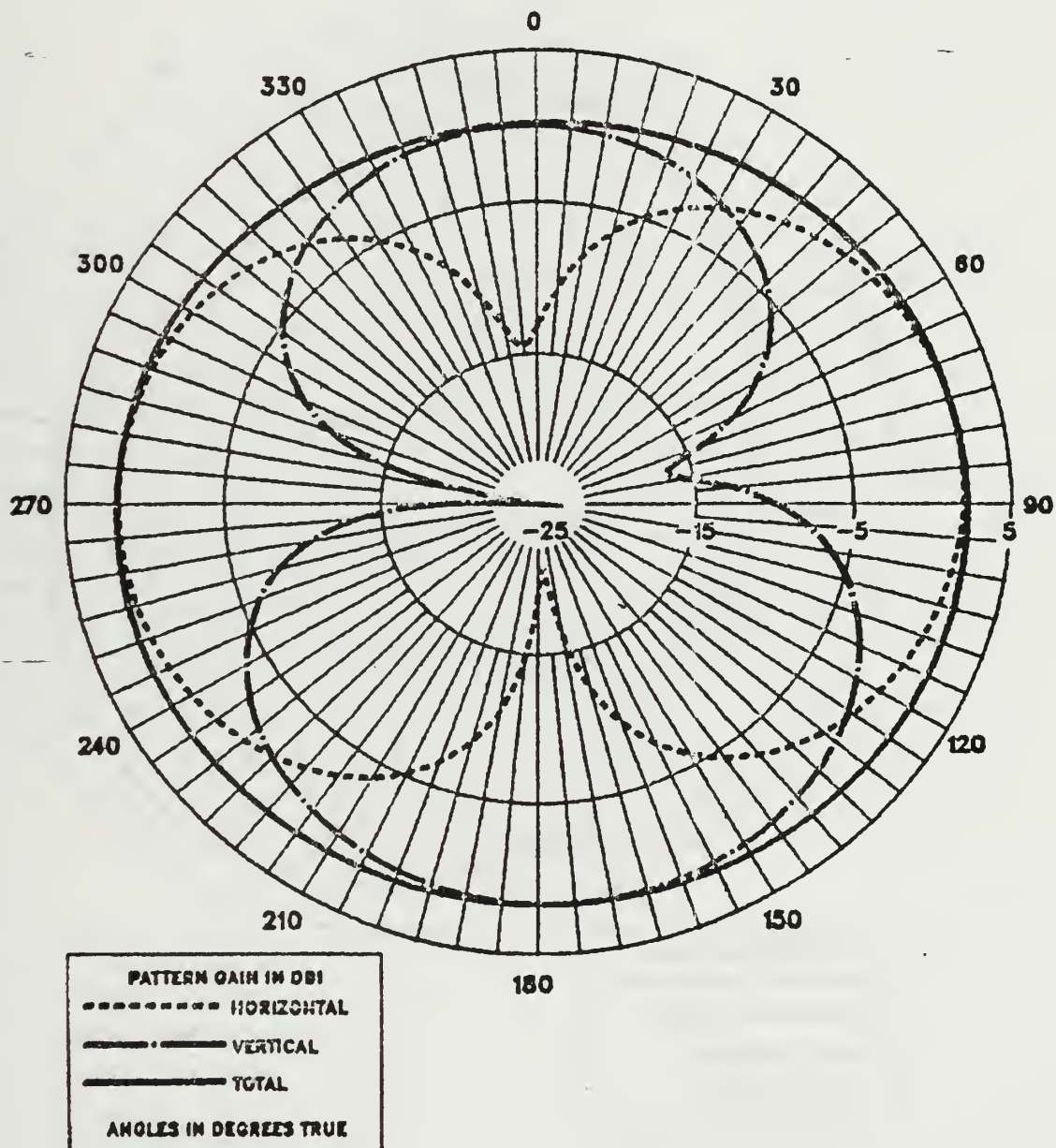
H60 IGUANA DATA RUN AT 7.645MHZ ON 8/21/87

NAVY 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=90



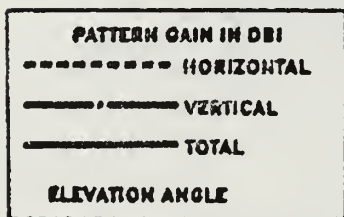
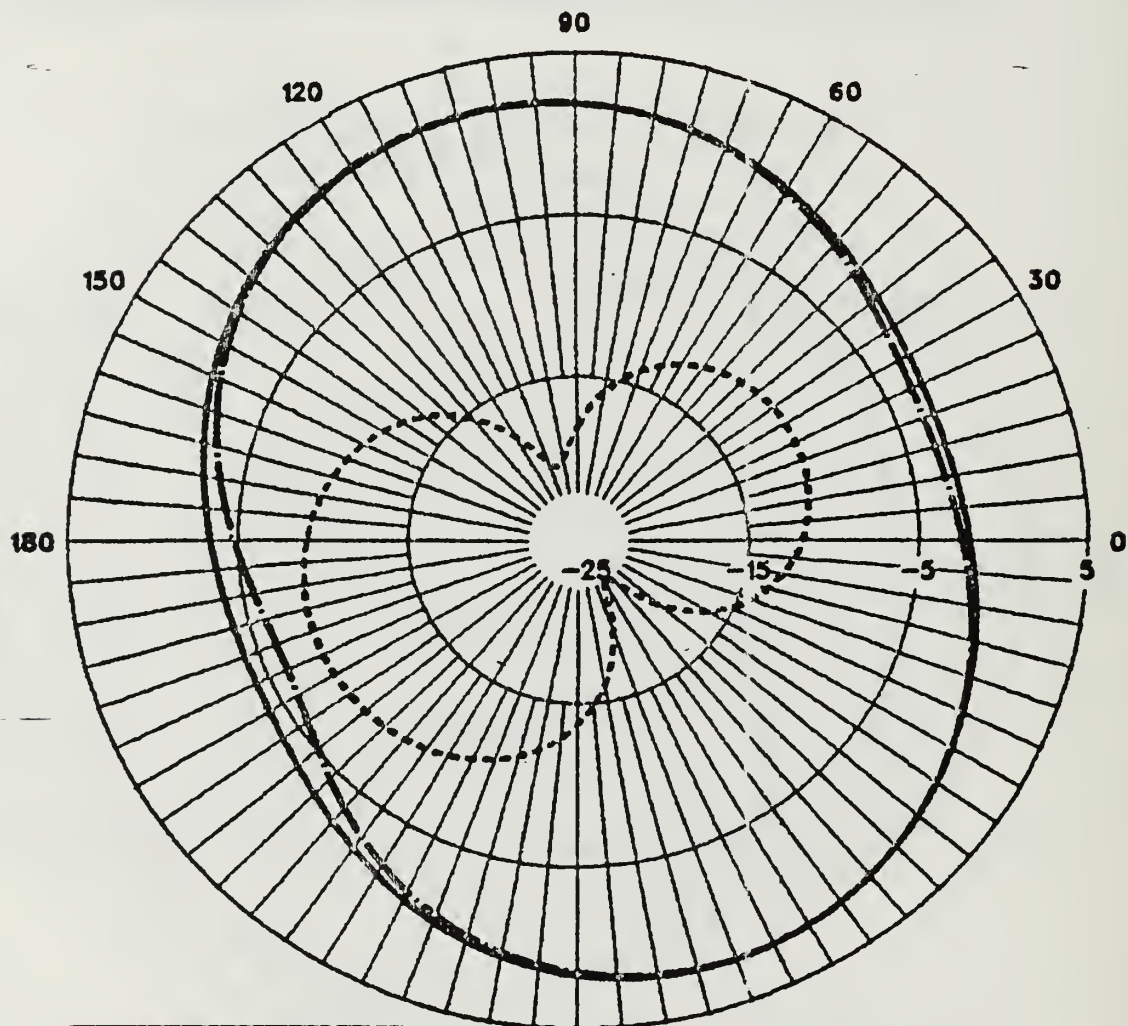
H60 IGUANA DATA RUN AT 7.645MHZ ON 8/21/87

NAVY 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=26



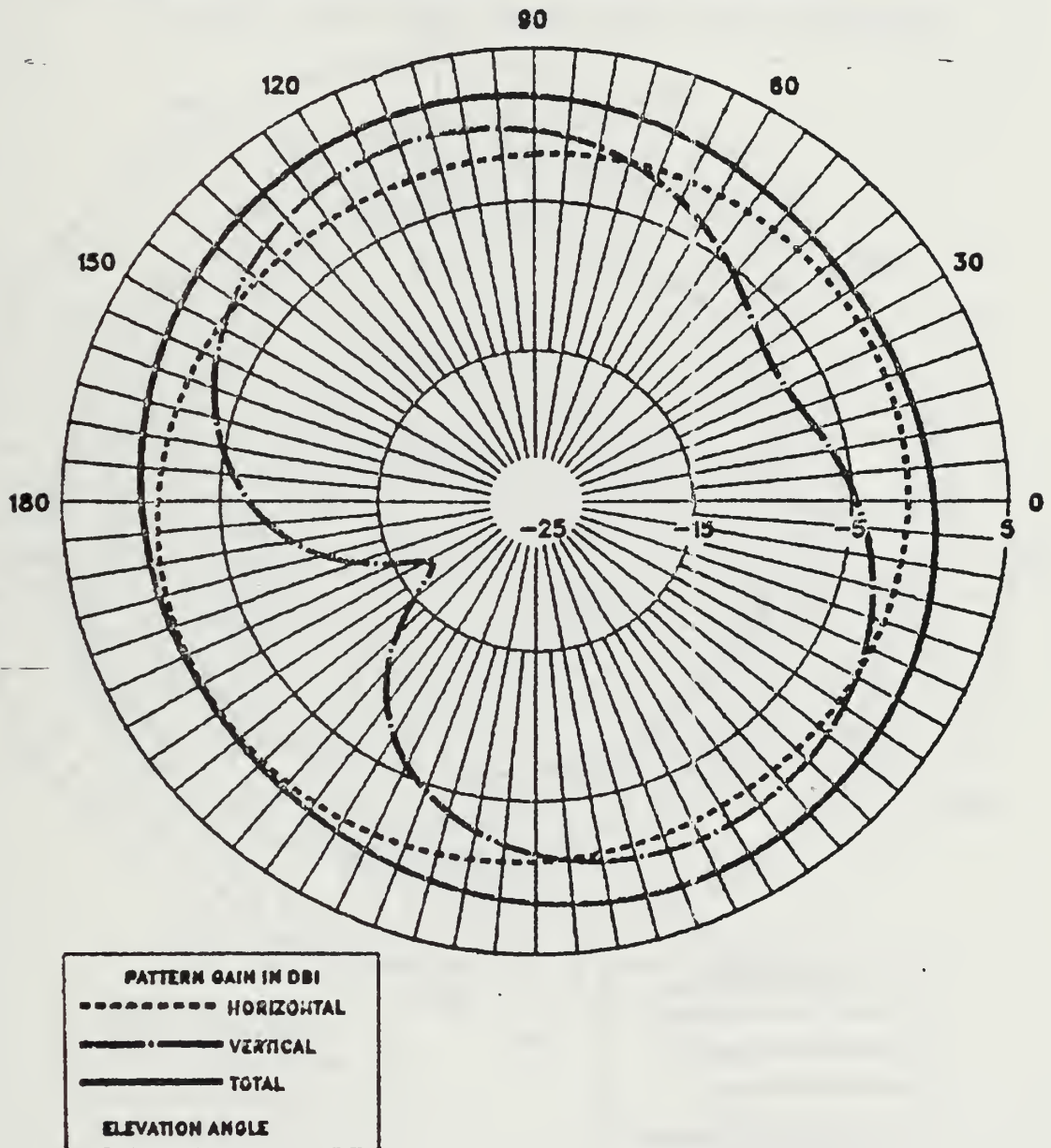
H60 IGUANA DATA RUN AT 7.645MHZ ON 8/21/87

NAVY 437R-2 ANT, FREE SPACE, VERT CUT, PHI=0



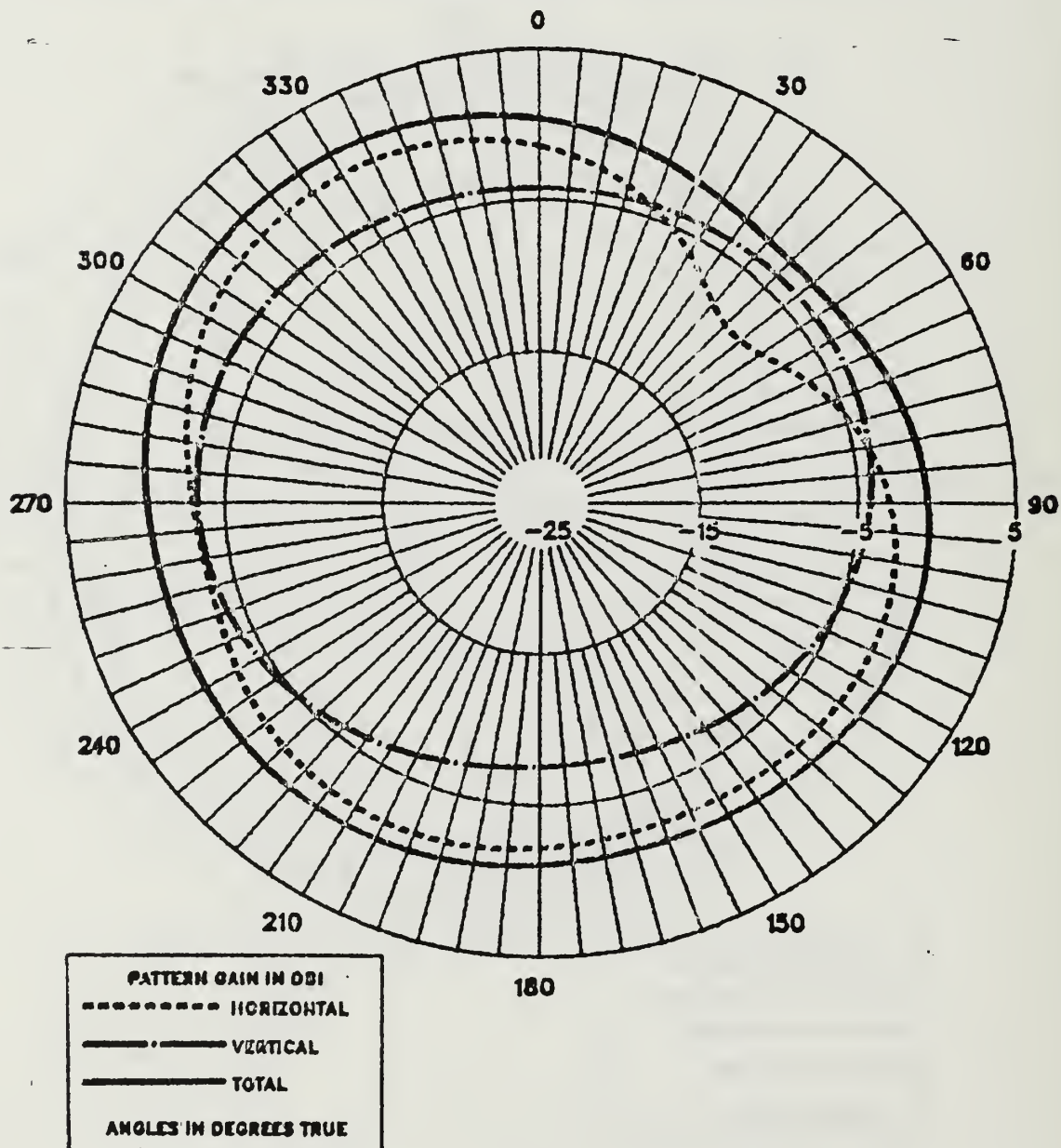
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NAVY 437R-2 ANT, FREE SPACE, VERT CUT, PHI=45



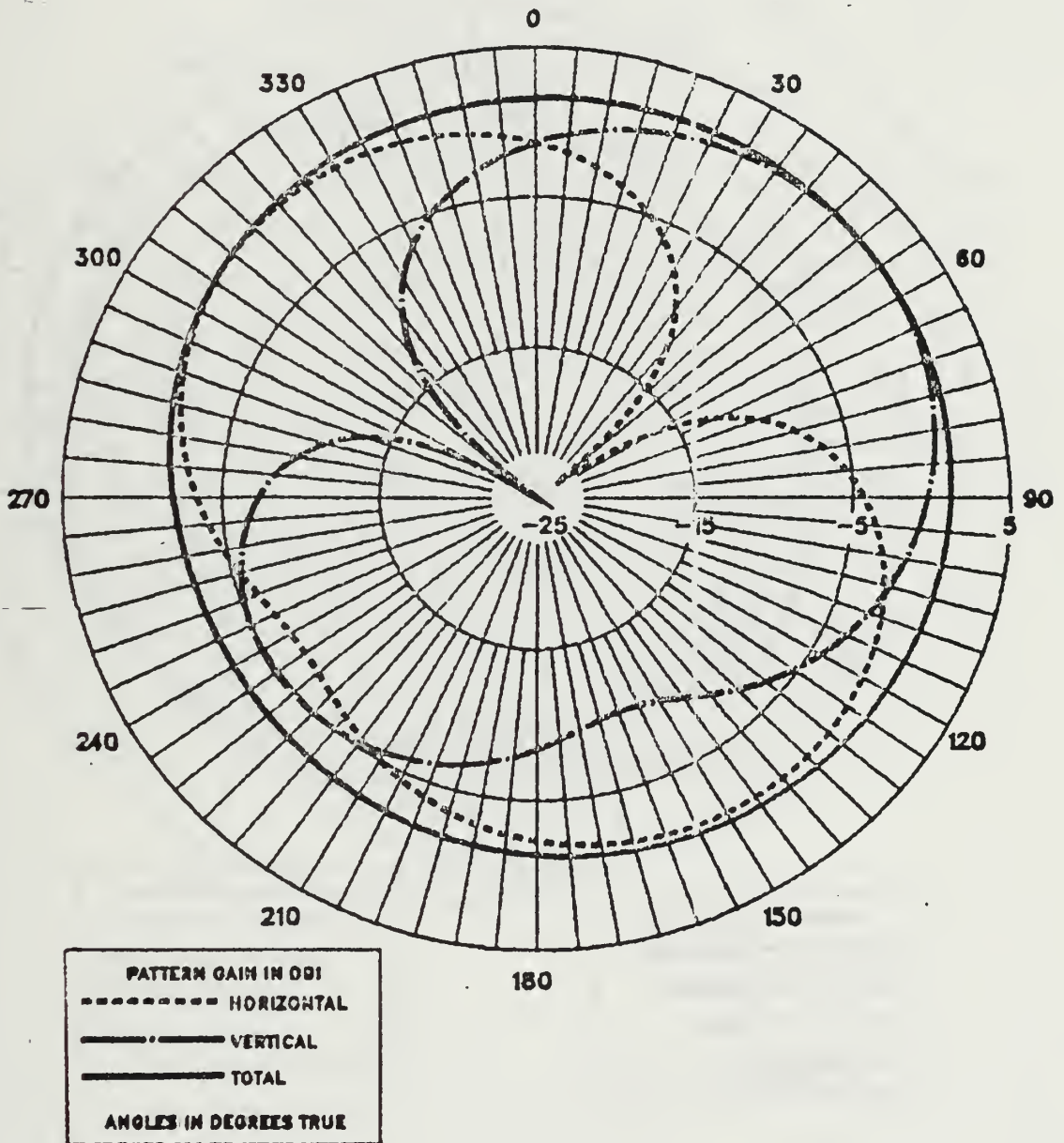
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CG 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=90



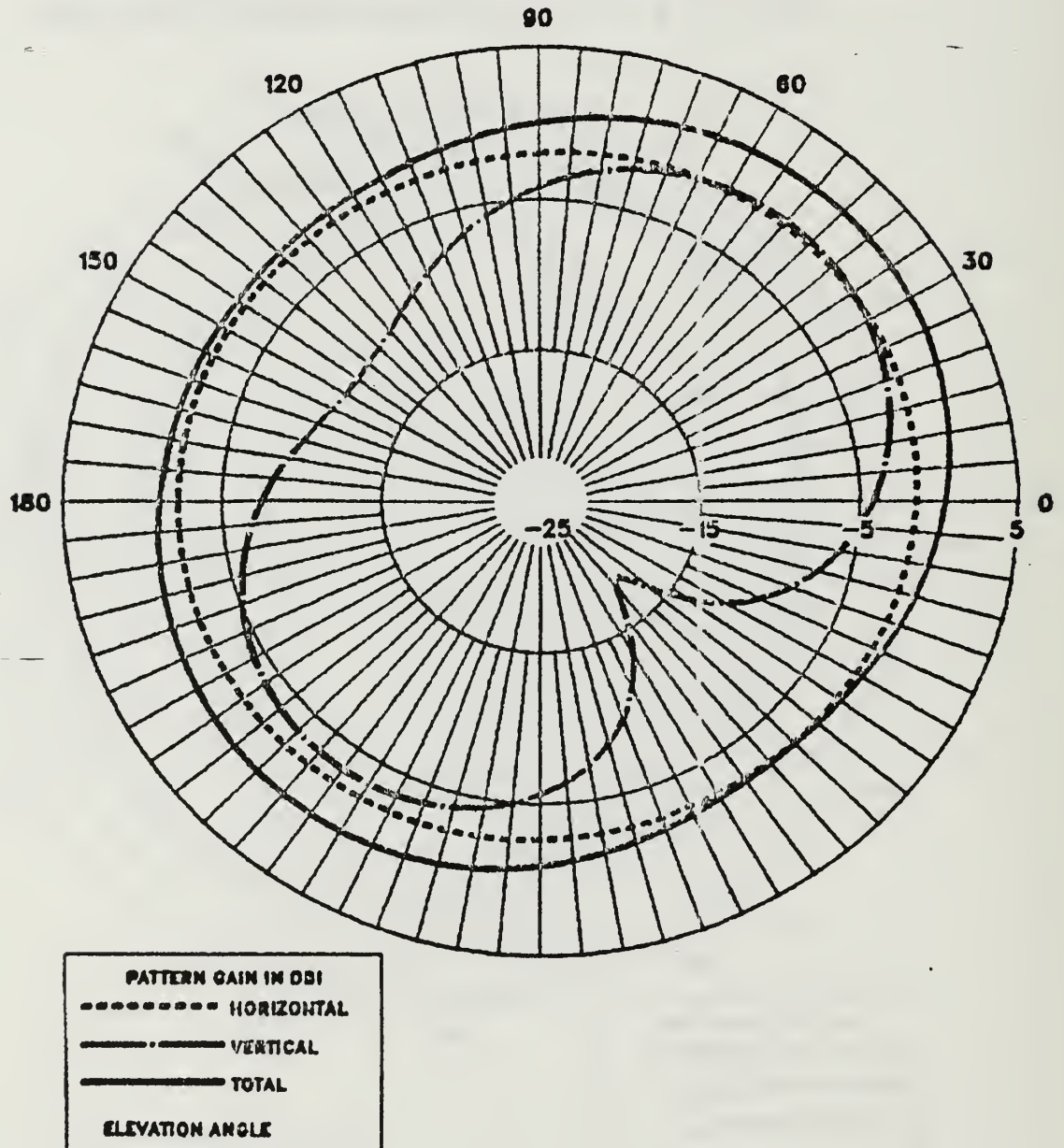
H60 IGUANA DATA RUN AT 7.645MHZ ON 8/21/87

CG 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=26



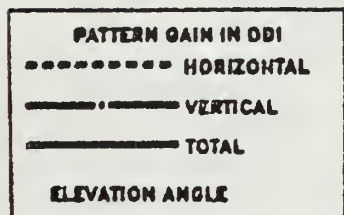
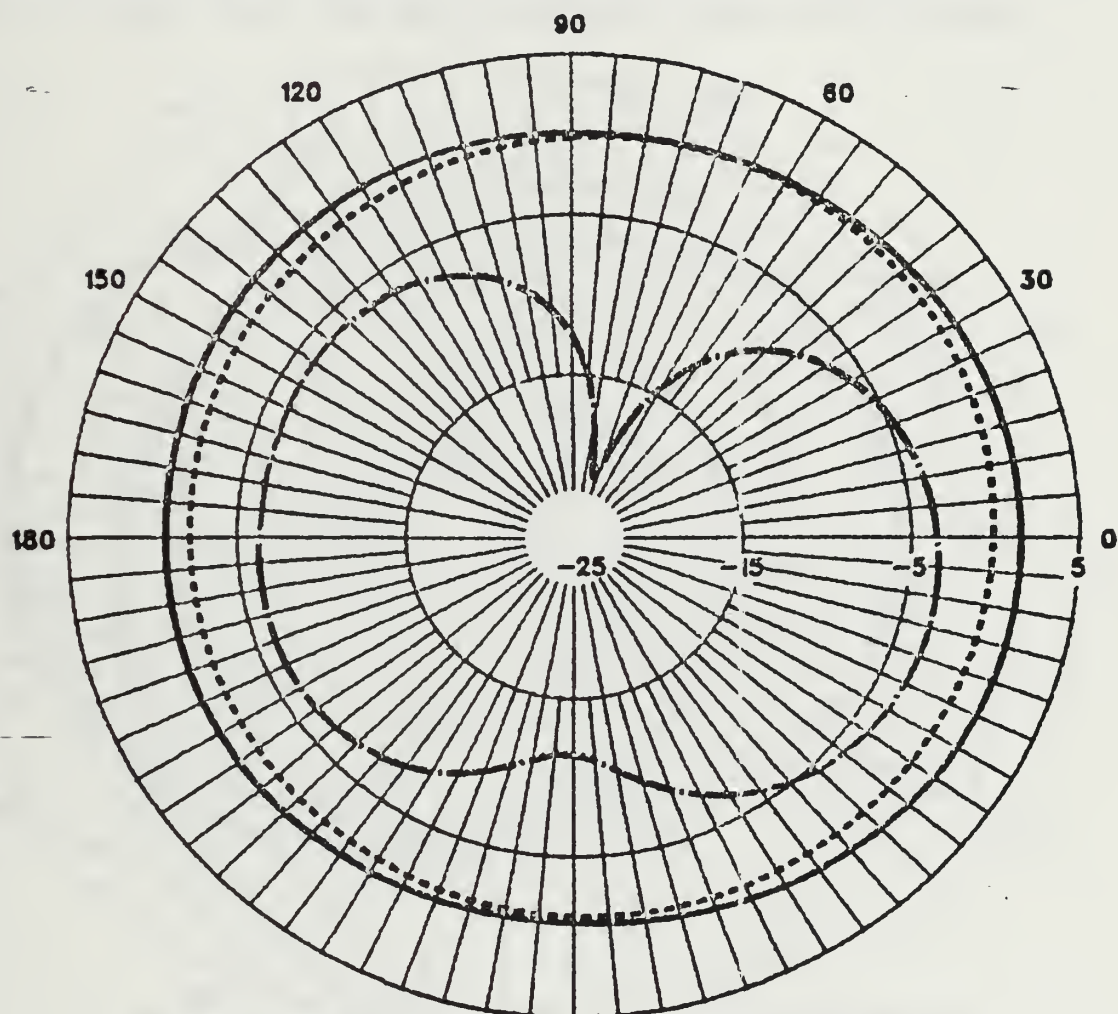
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CG 437R-2 ANT, FREE SPACE, VERT CUT, PHI=0



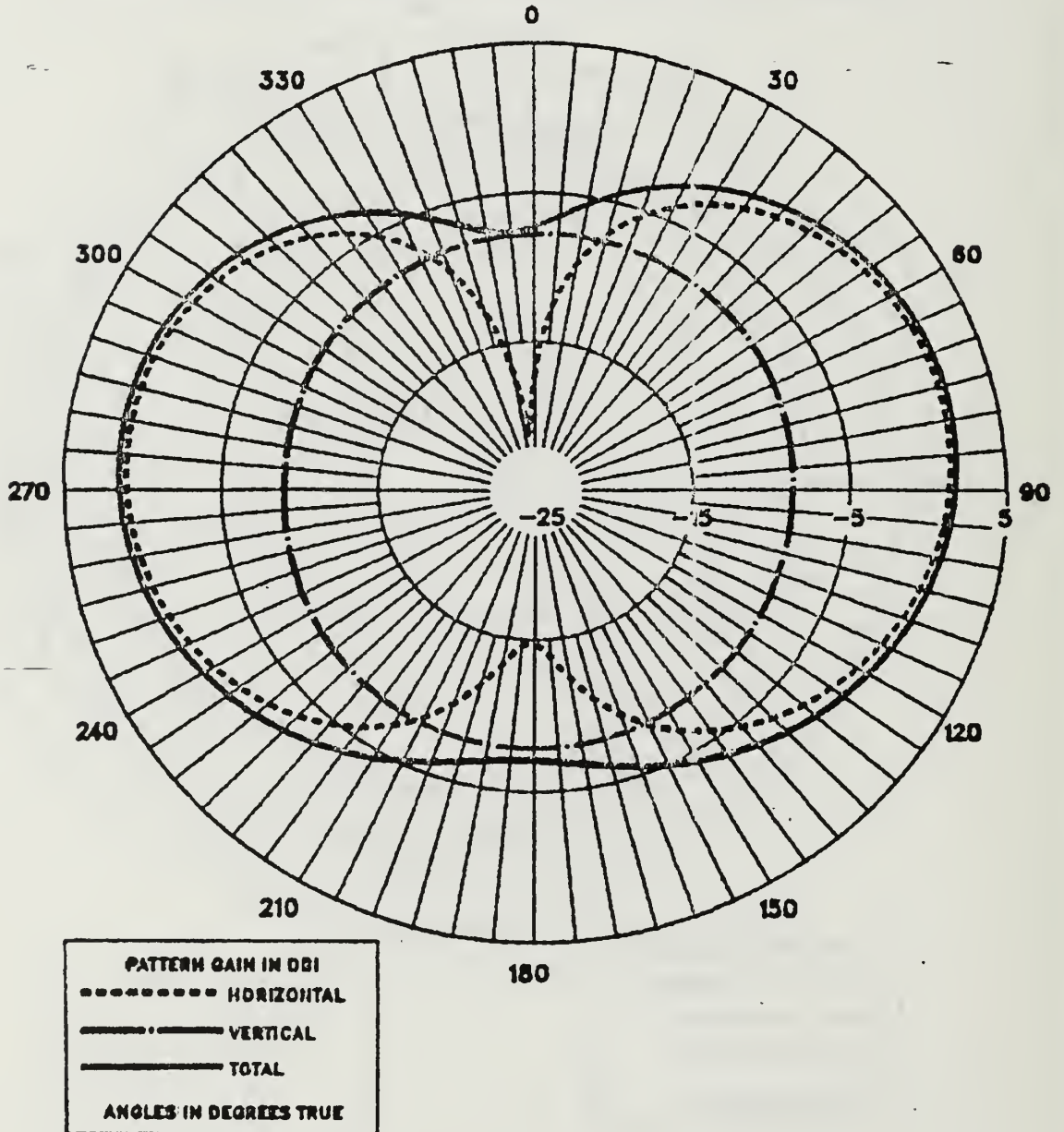
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CG 437R-2 ANT, FREE SPACE, VERT CUT, PHI=45



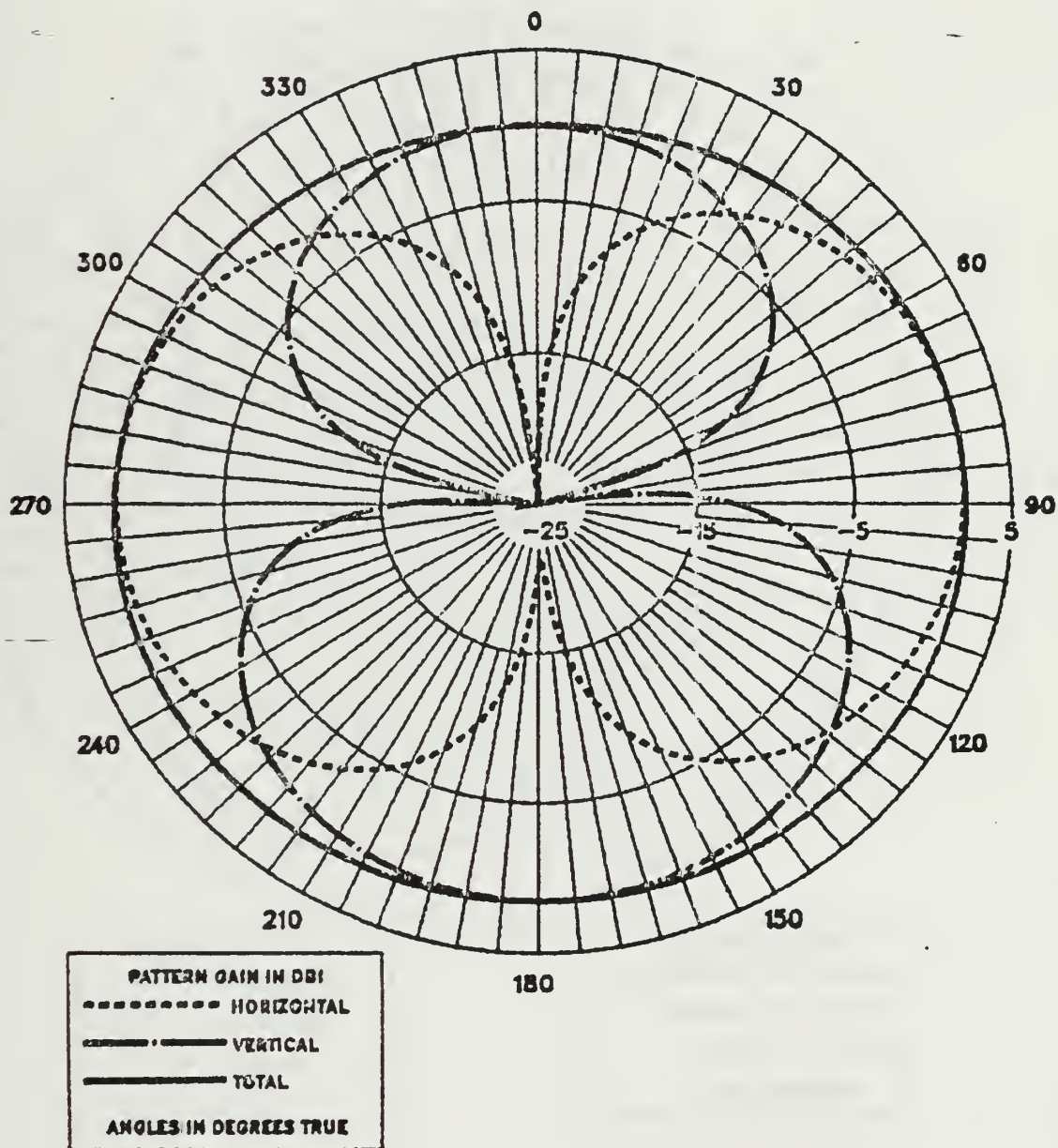
H60 IGUANA DATA RUN AT 7.645MHZ ON 8/21/87

ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CUT, THETA=90



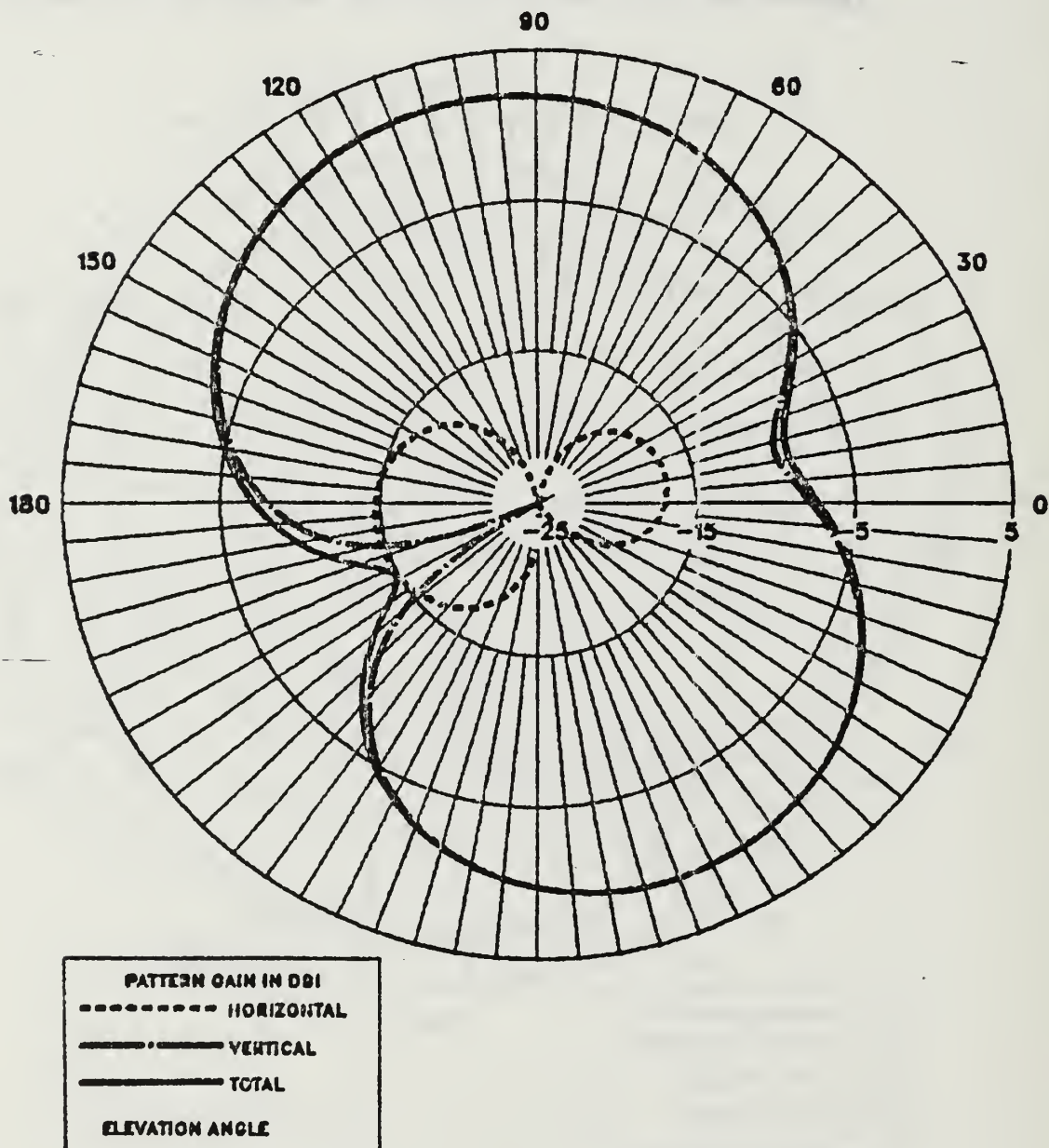
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ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CUT, THETA=26



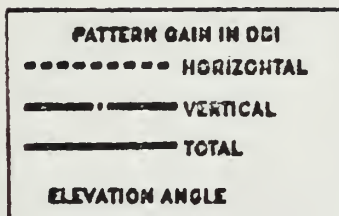
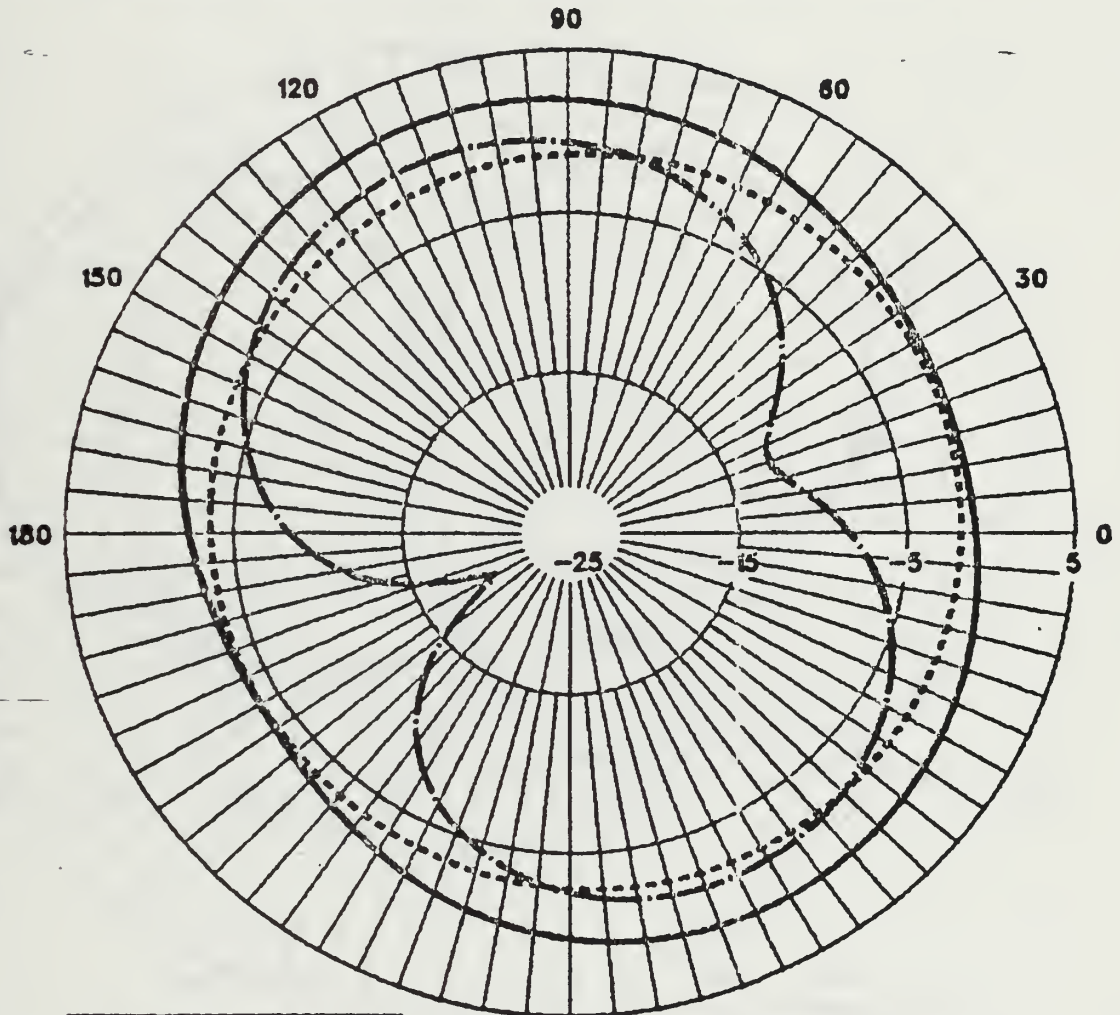
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ARMY-TYPE TUBE ANT, FREE SPACE, VERT CUT, PHI=0



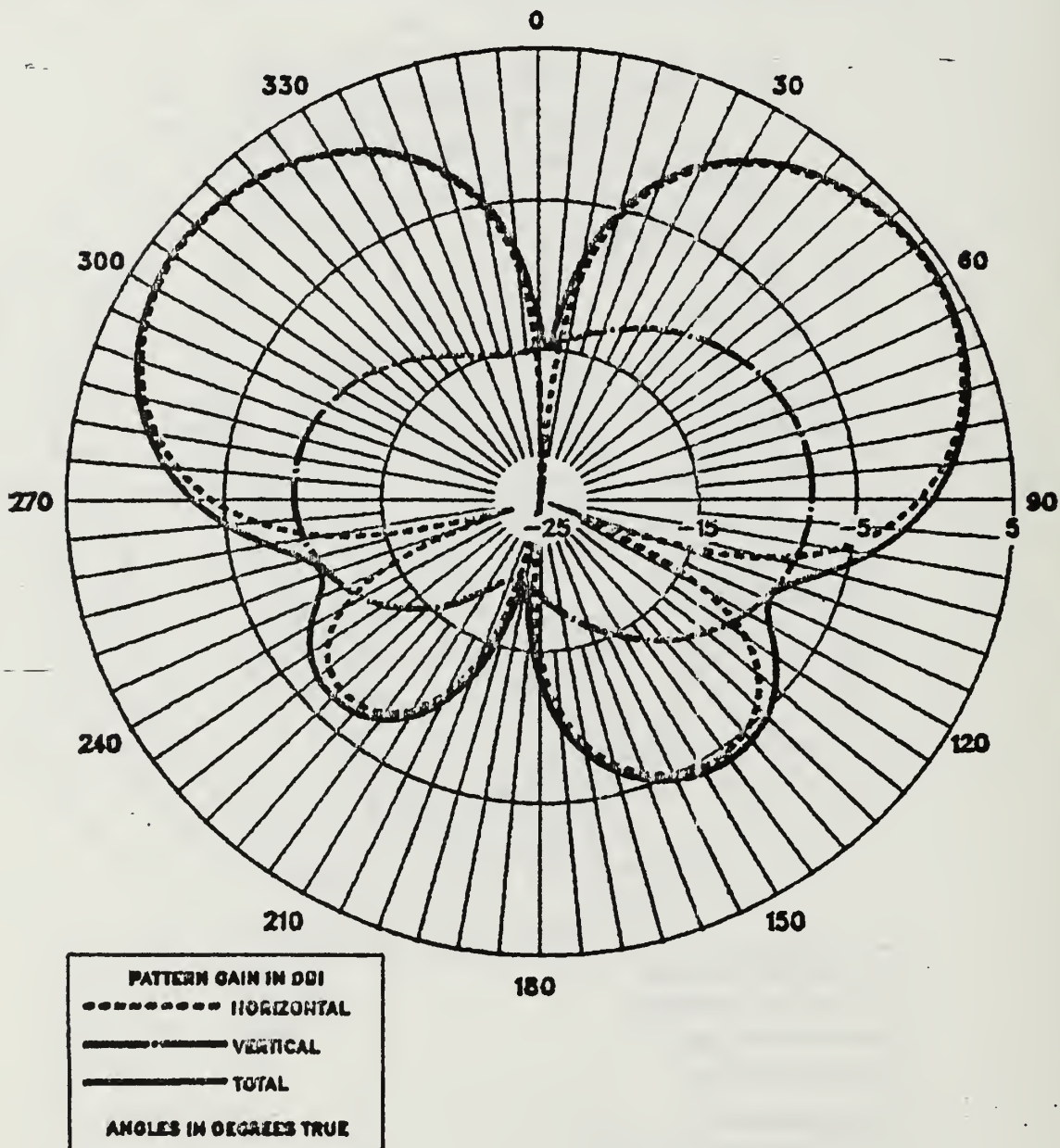
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ARMY-TYPE TUBE ANT, FREE SPACE, VERT CUT, PHI=45



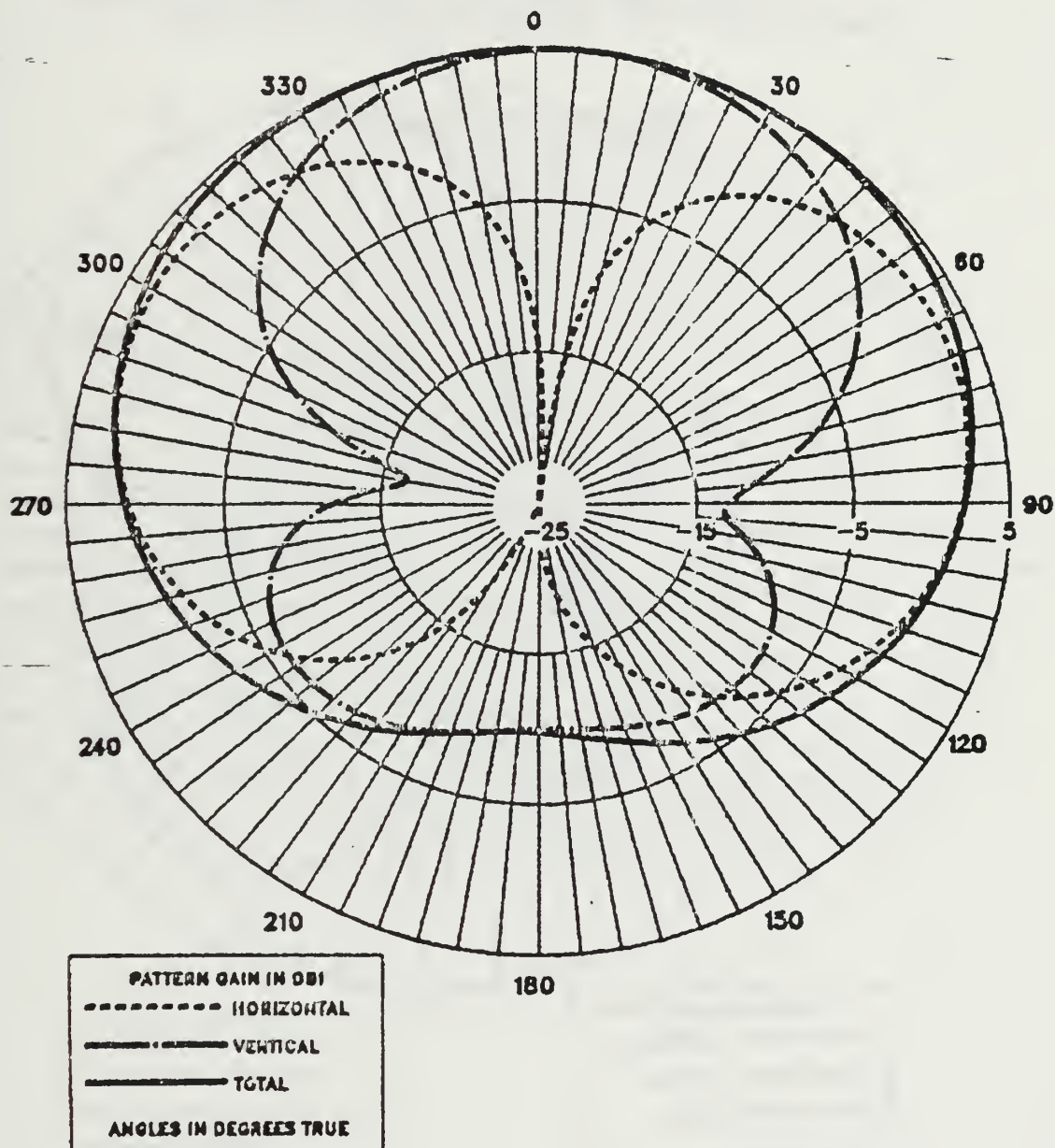
H60 IGUANA DATA RUN AT 8.984MHZ ON 8/24/87

LONG-WIRE ANT, FREE SPACE, HORIZ CUT, THETA=90



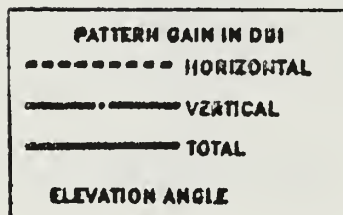
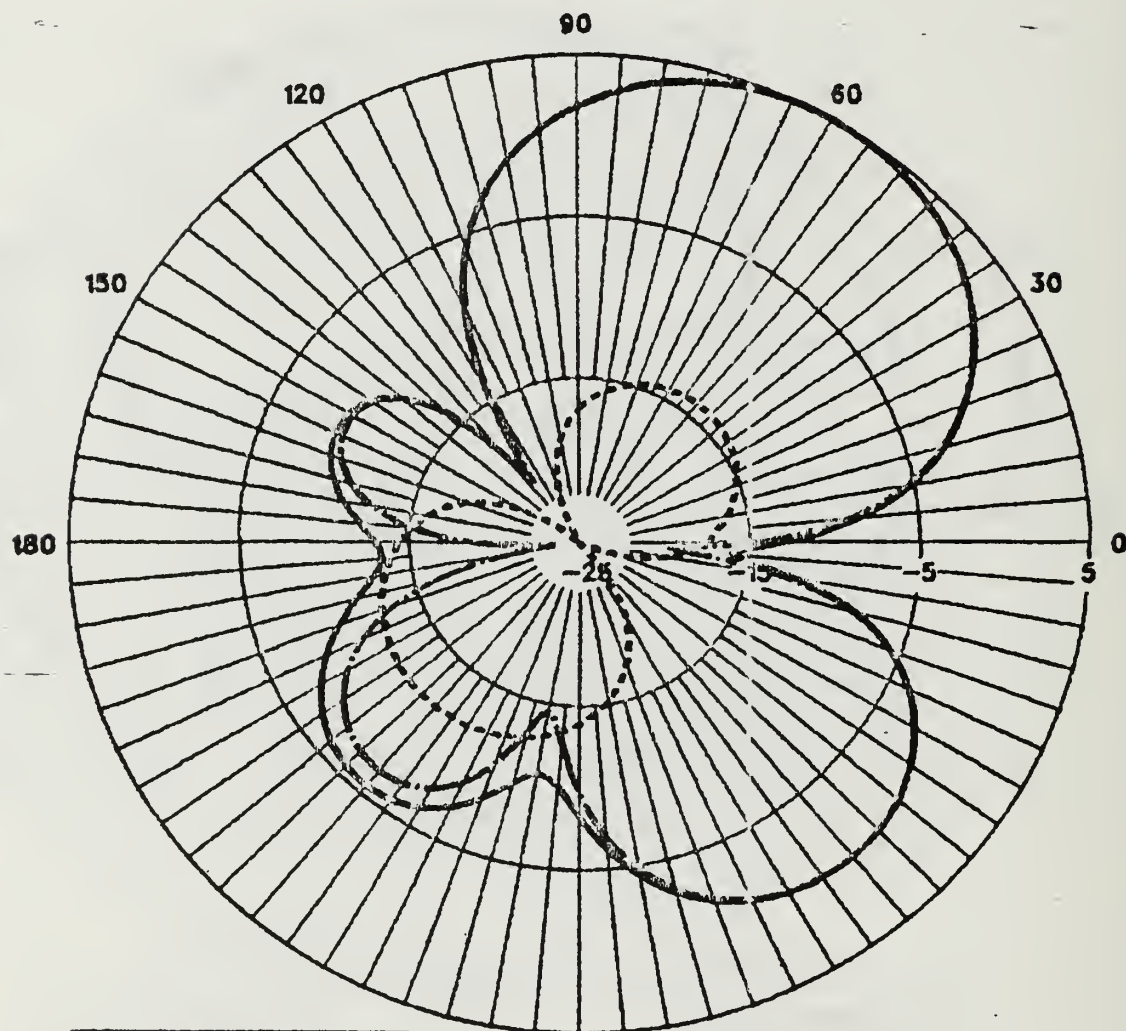
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LONG-WIRE ANT, FREE SPACE, HORIZ CUT, THETA=26



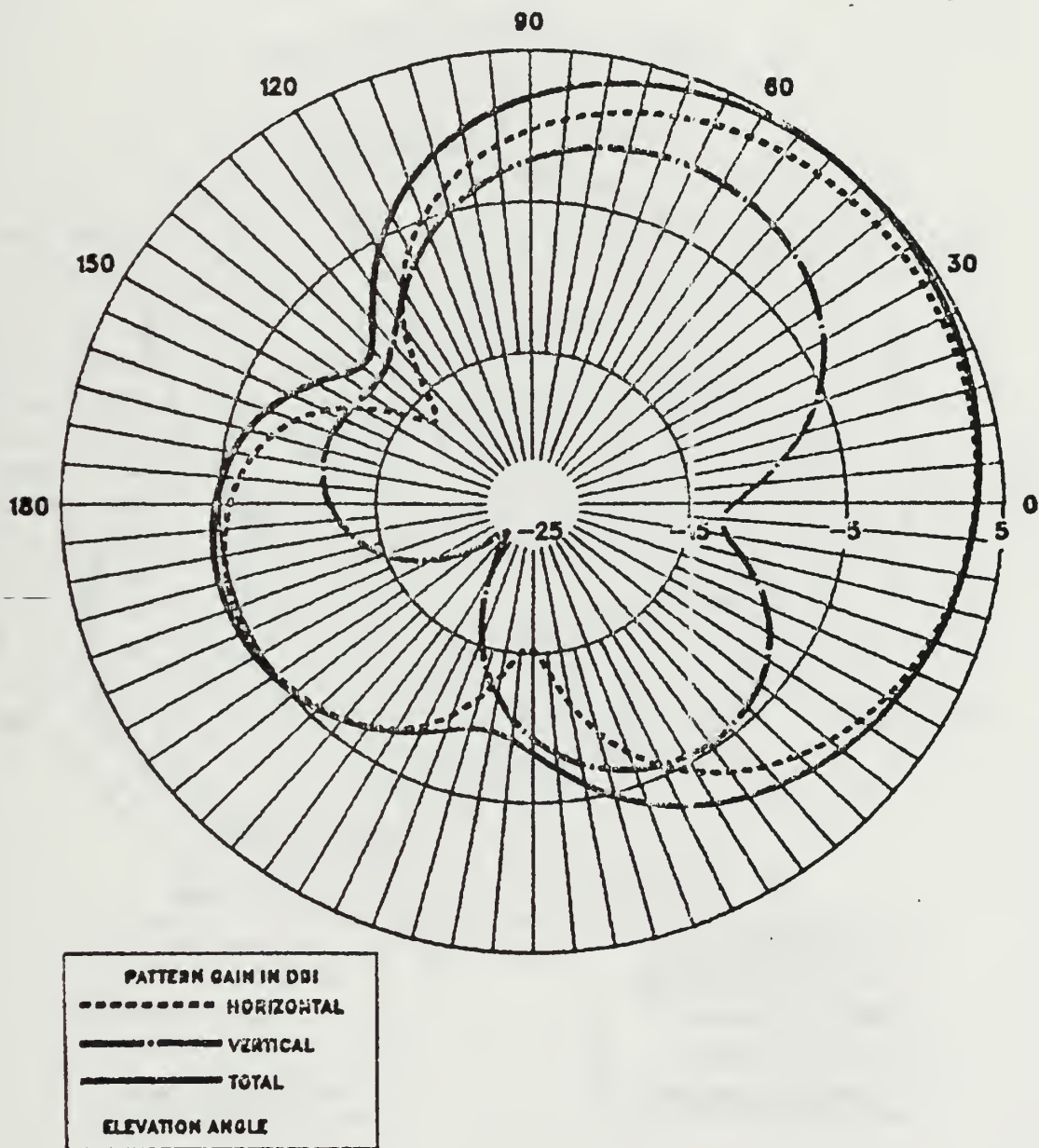
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LONG-WIRE ANT, FREE SPACE, VERT CUT, PHI=0



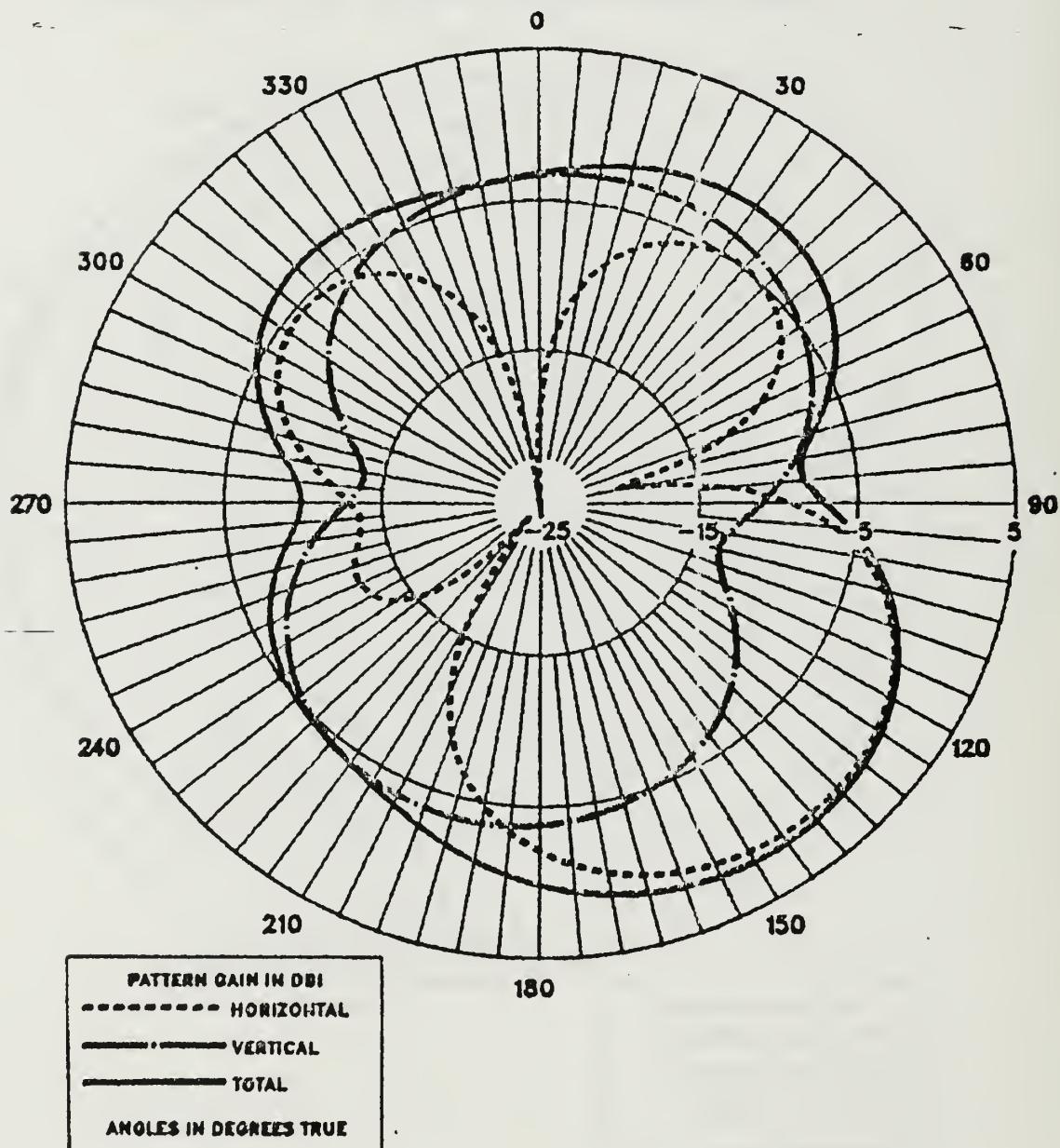
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LONG-WIRE ANT, FREE SPACE, VERT CUT, PHI=45



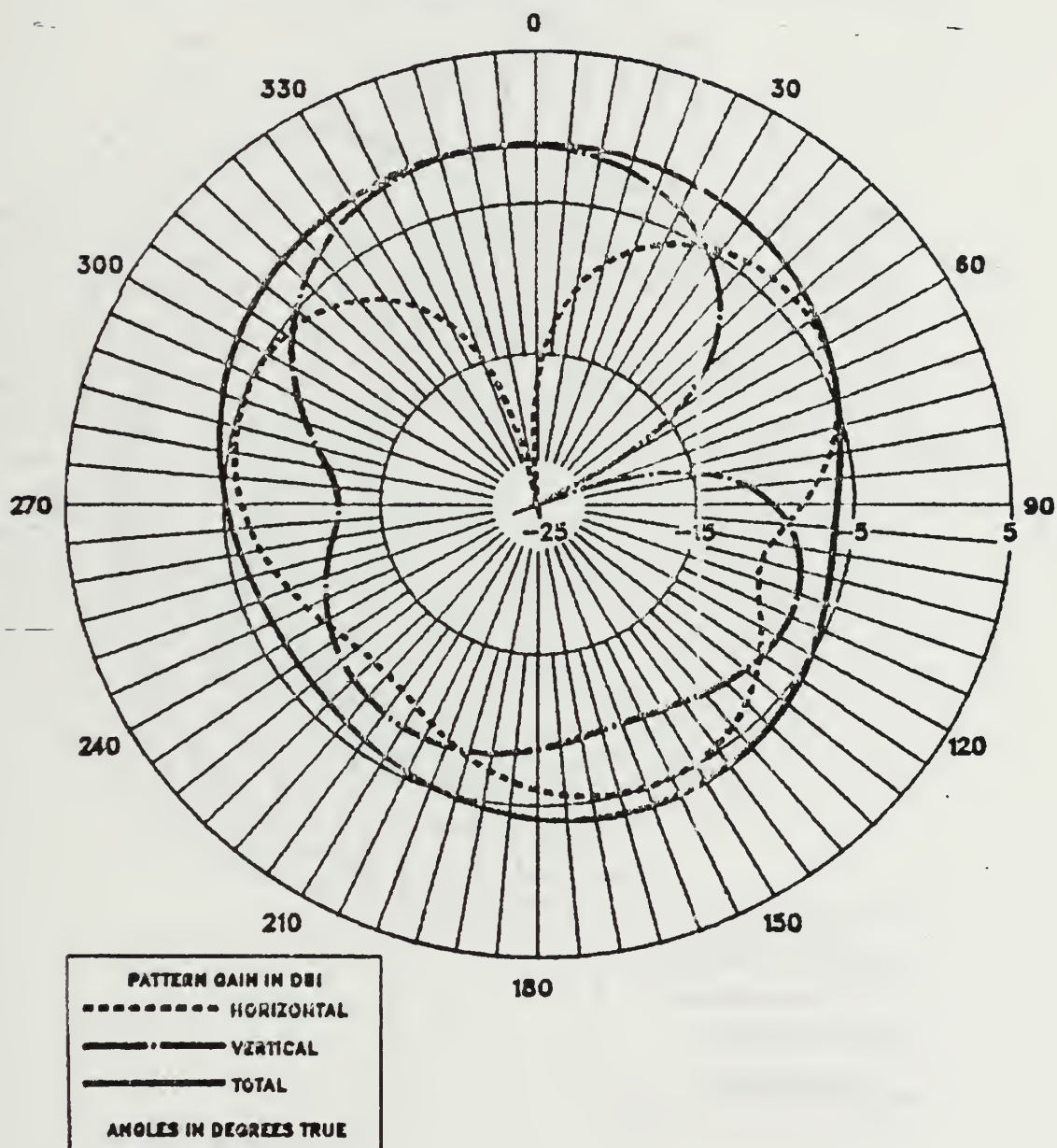
H60 IGUANA DATA RUN AT 8.984MHZ ON 8/24/87

NAVY 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=90



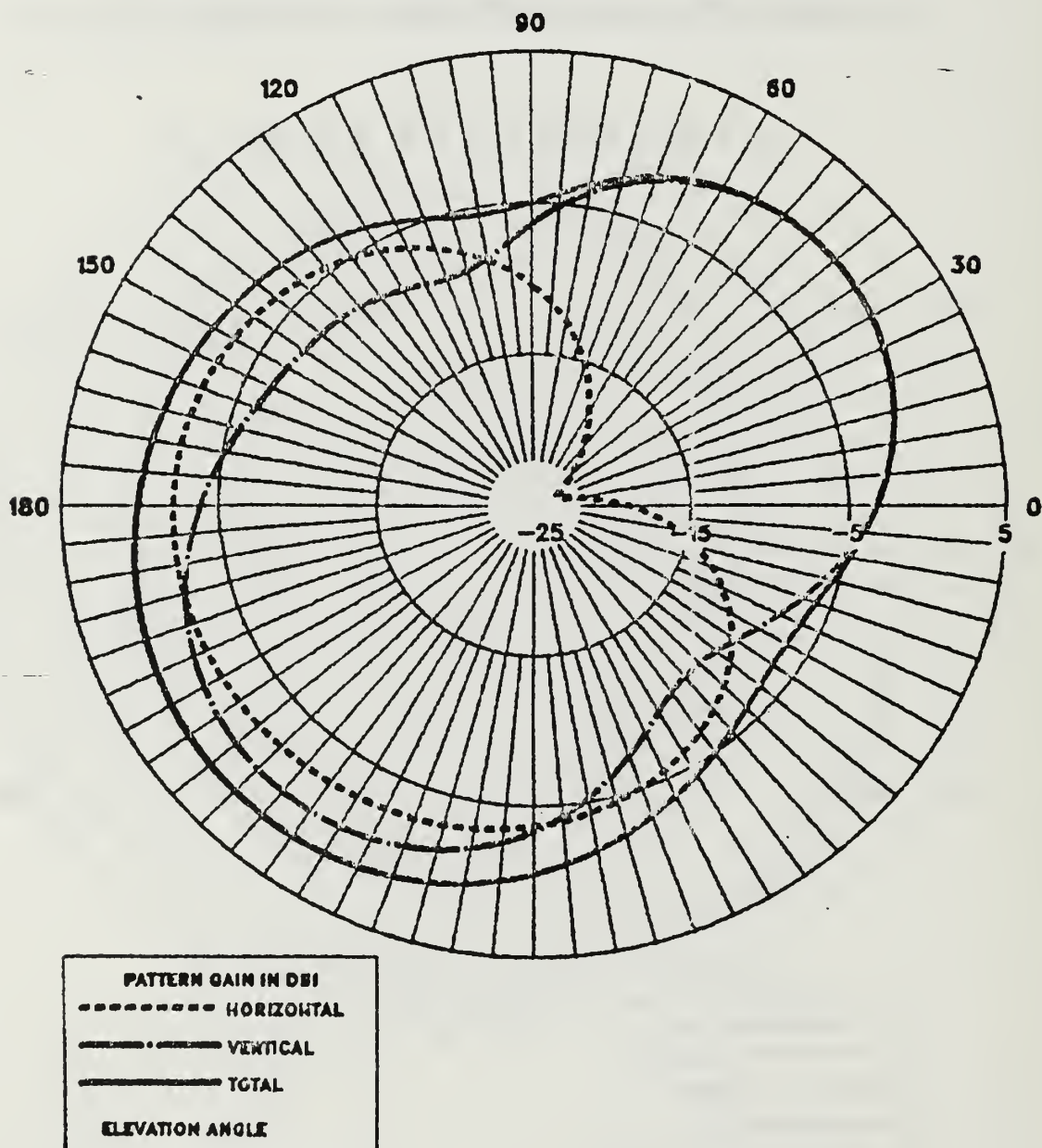
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NAVY 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=26



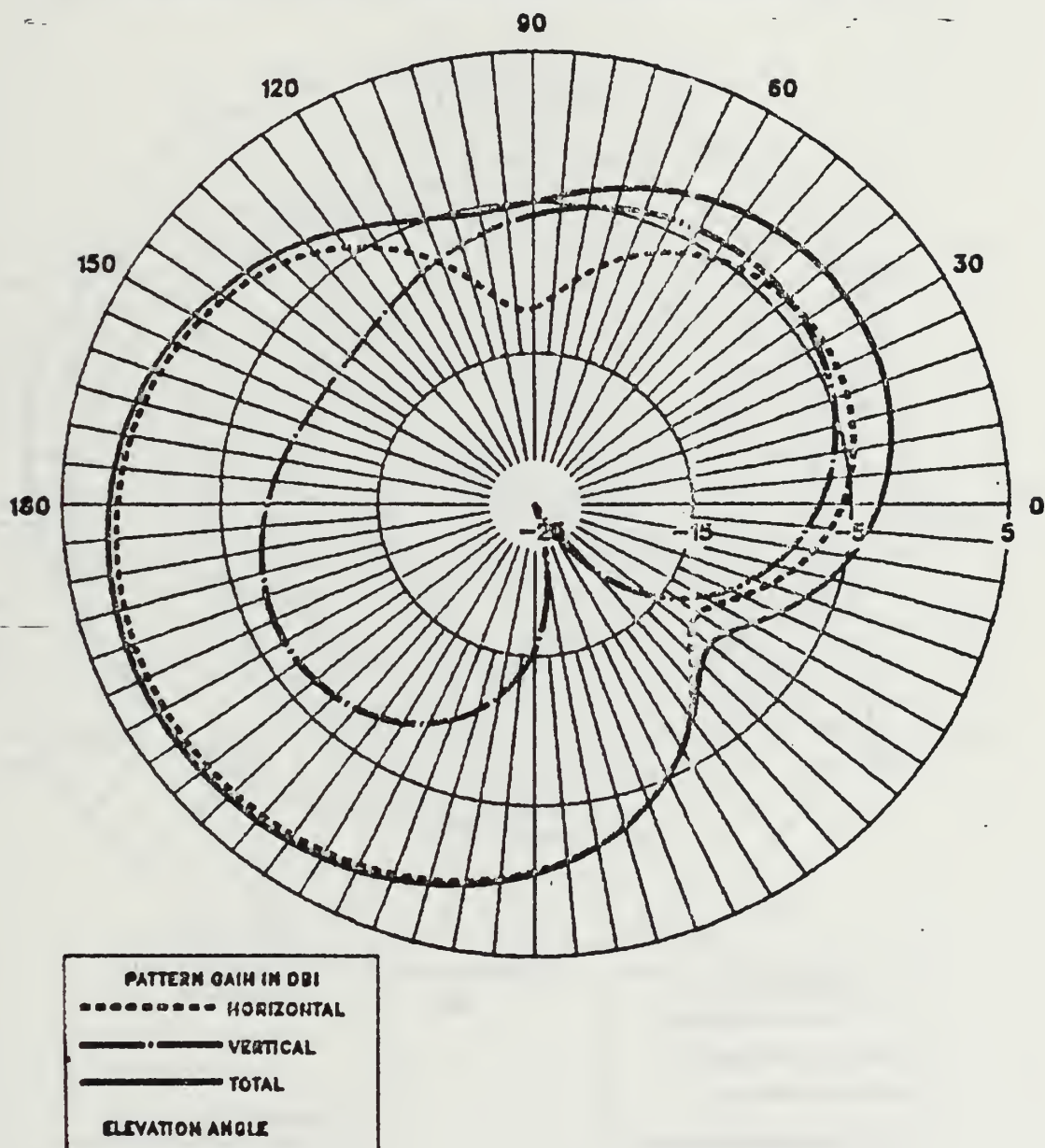
H60 IGUANA DATA RUN AT 8.984MHZ ON 8/24/87

NAVY 437R-2 ANT, FREE SPACE, VERT CUT, $\Phi=0$



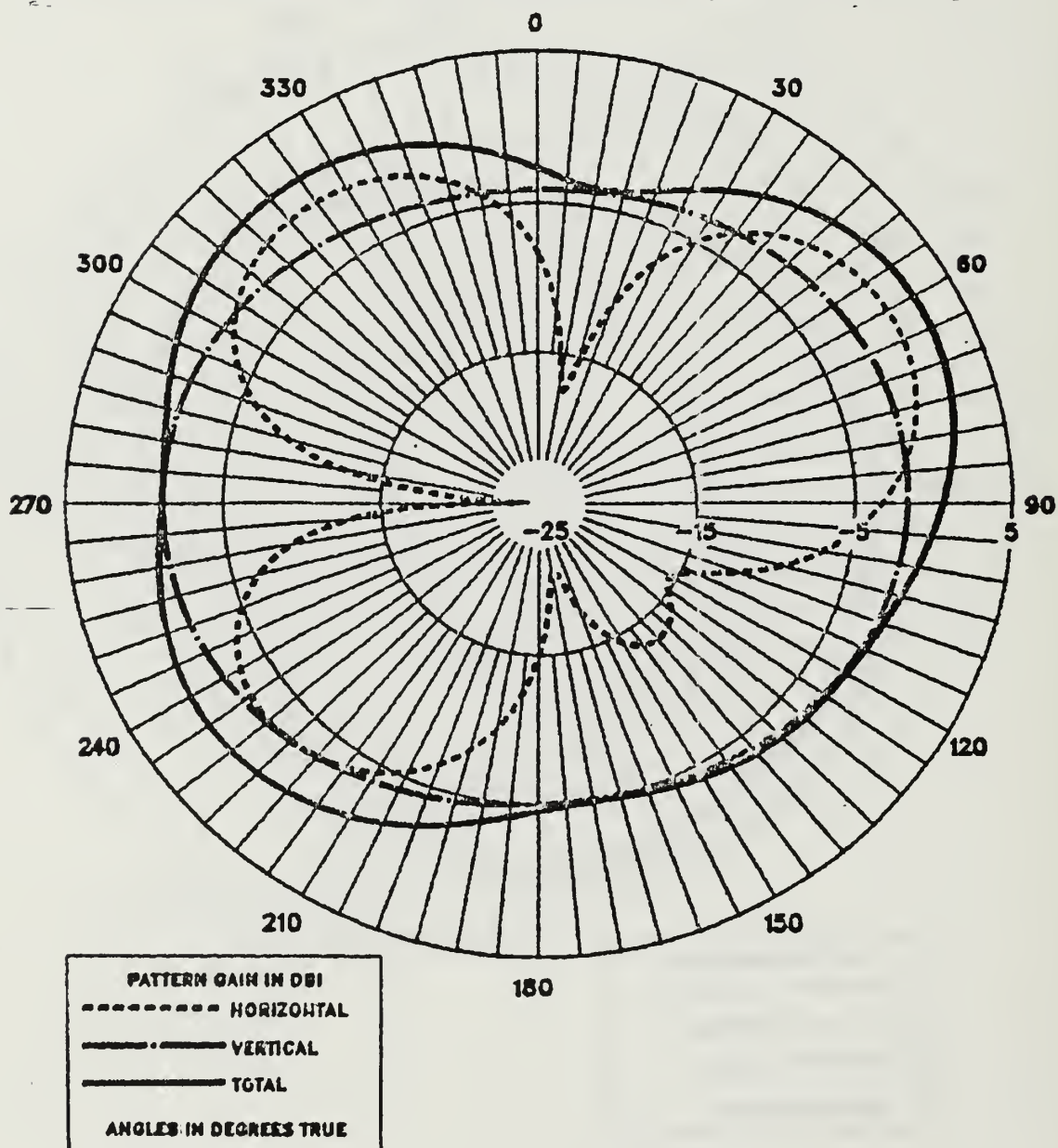
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NAVY 437R-2 ANT, FREE SPACE, VEI XT CUT, PHI=45



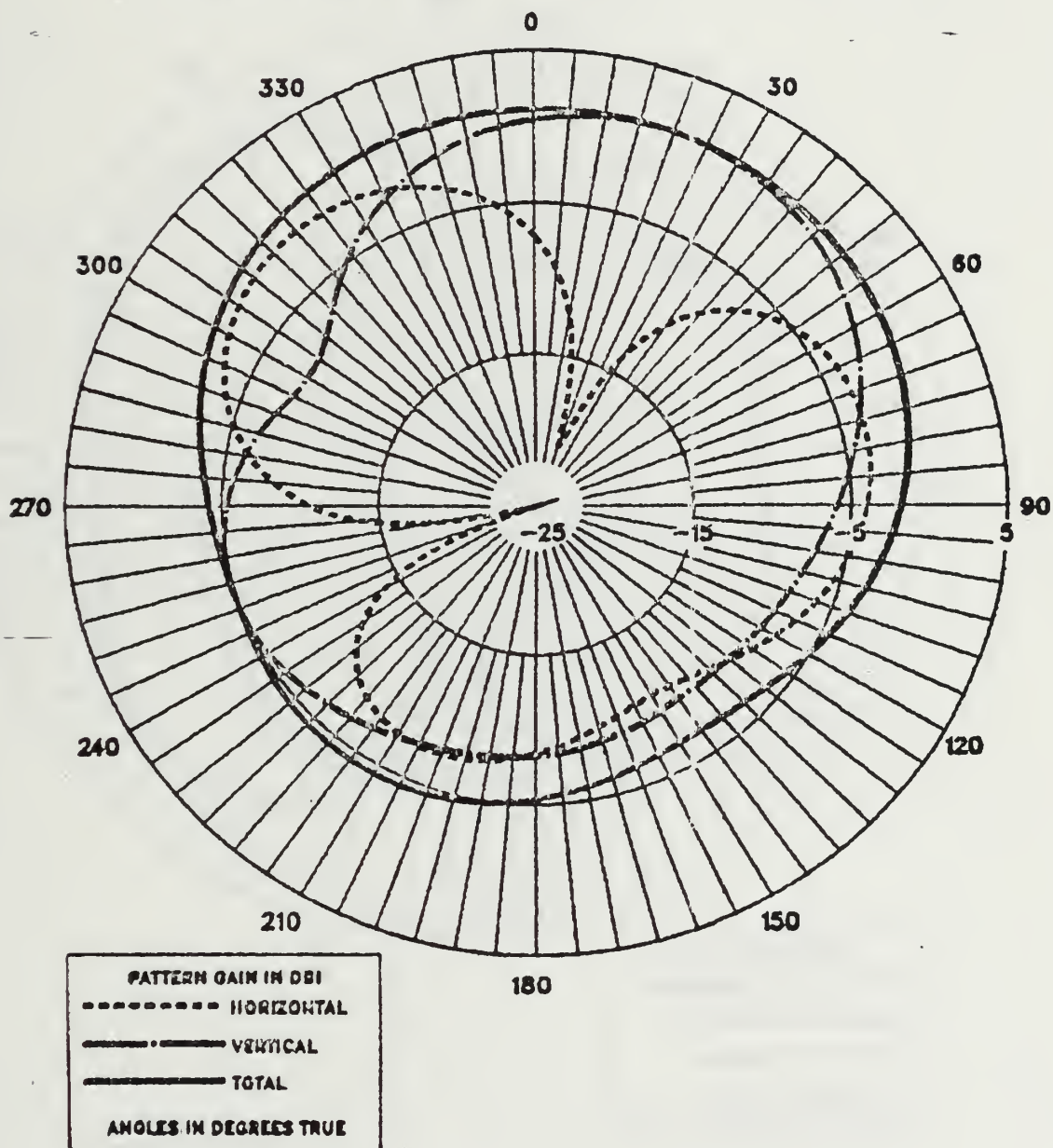
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CG 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=90



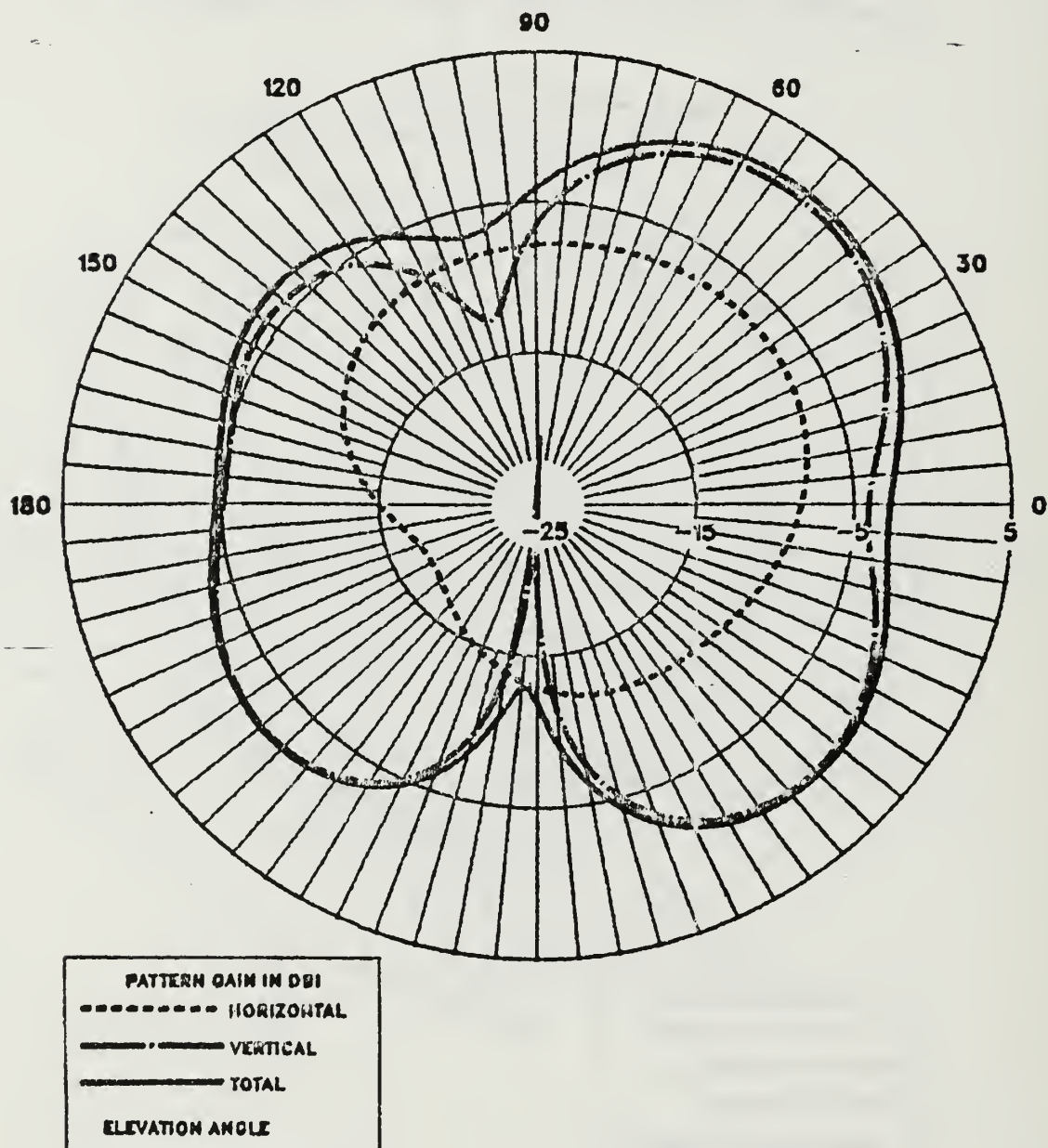
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CG 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=26



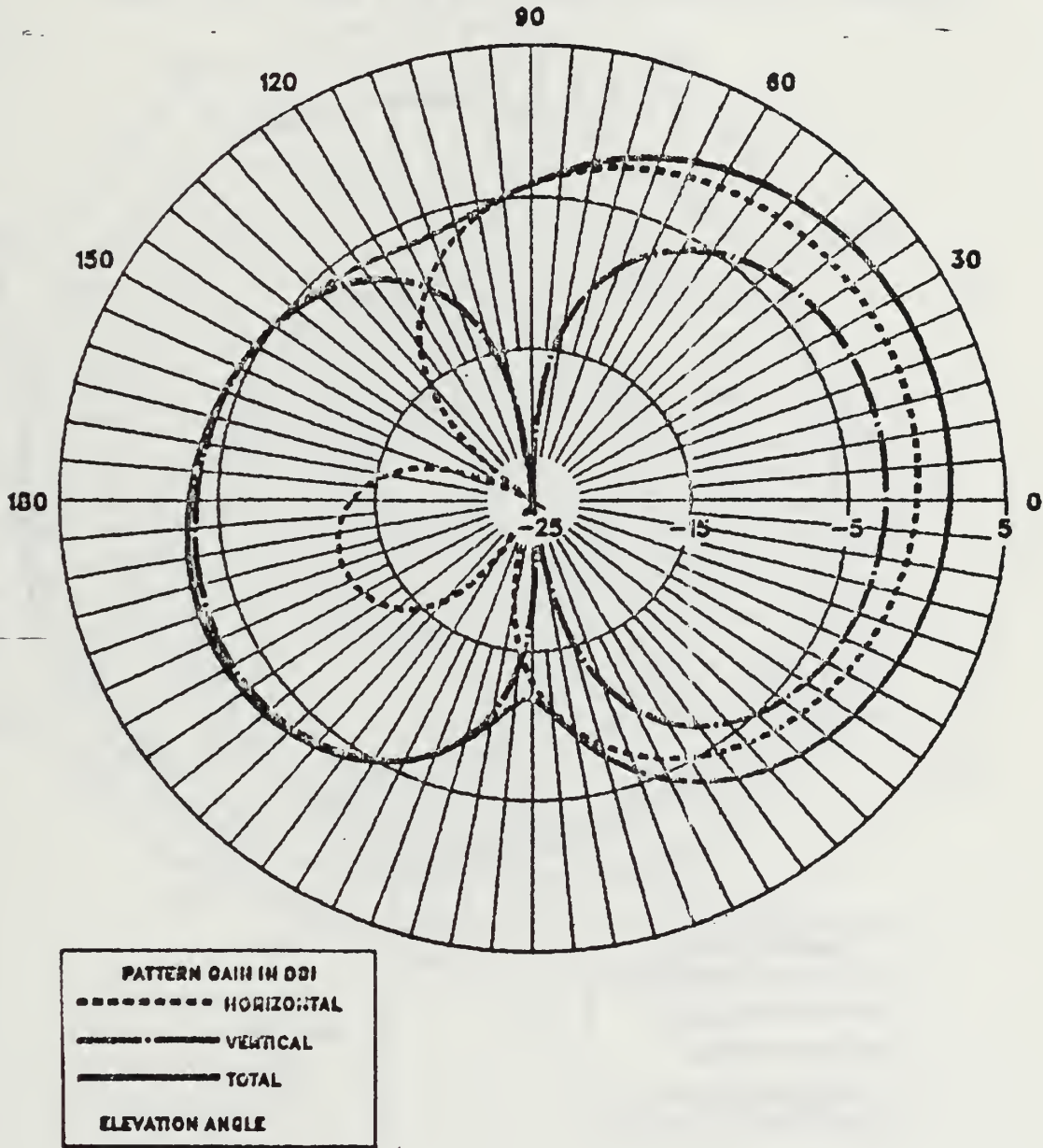
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CG 437R-2 ANT, FREE SPACE, VERT CUT, PHI=0



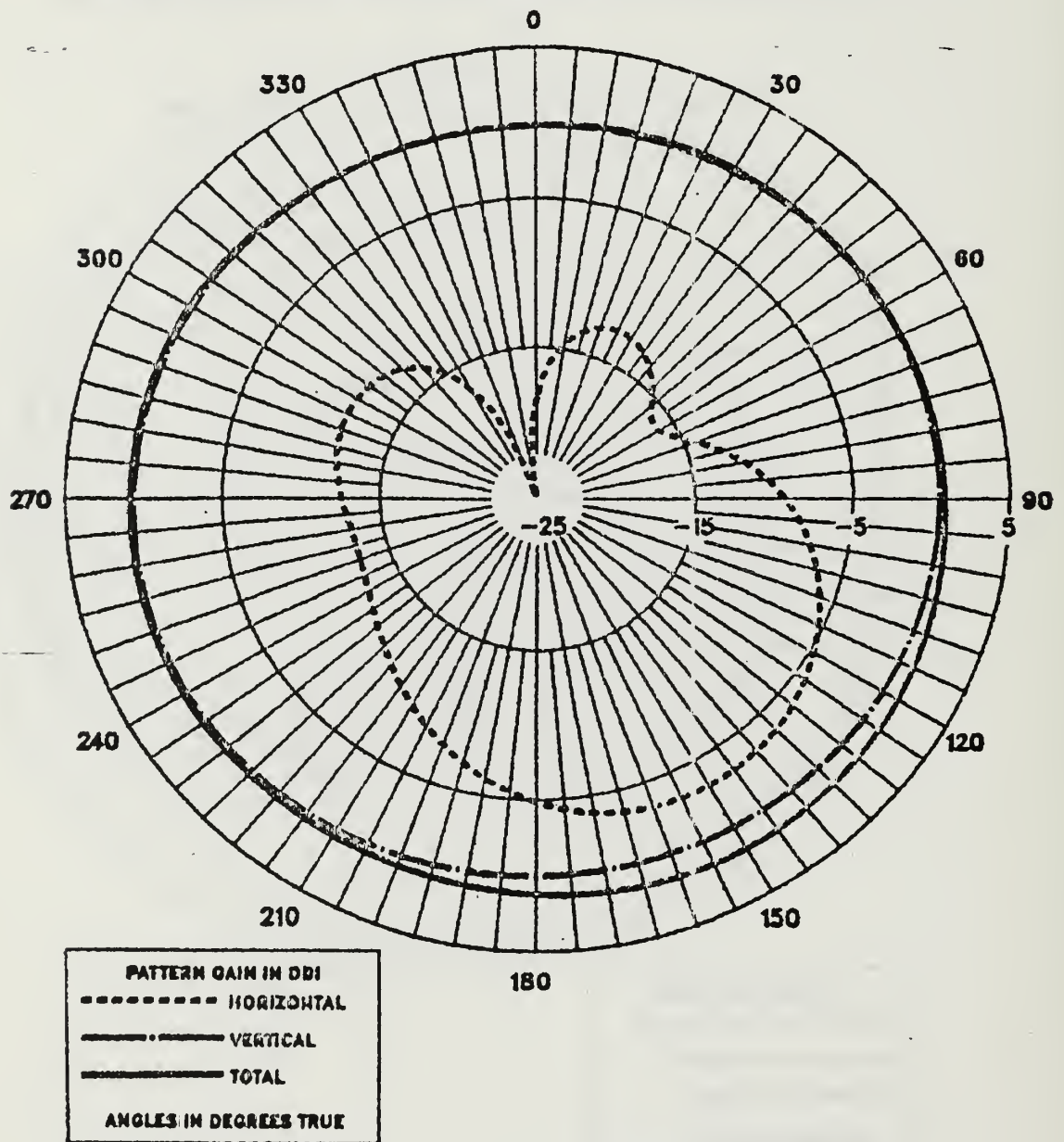
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CG 437R-2 ANT, FREE SPACE, VERT CUT, PHI=45



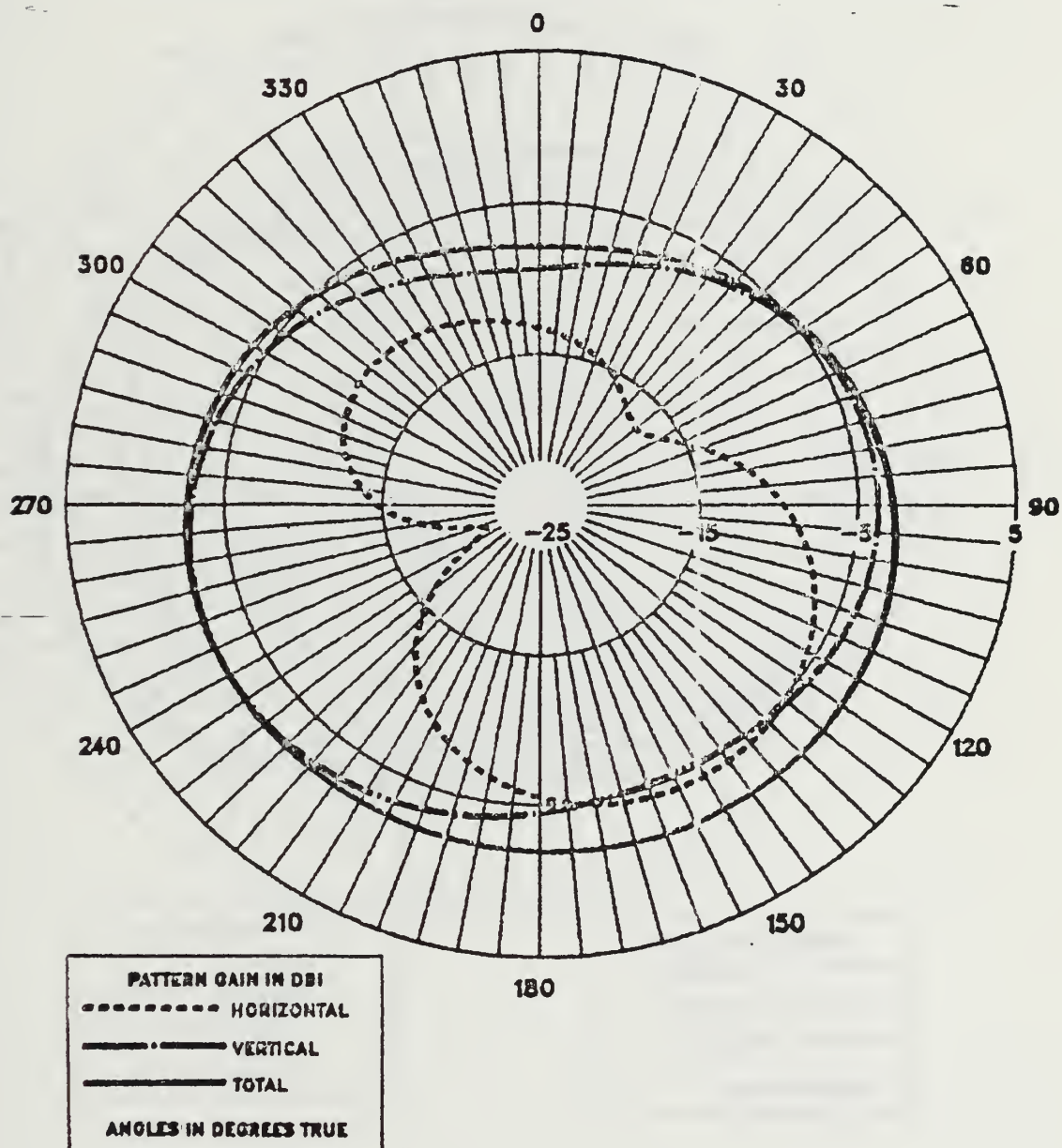
H60 IGUANA DATA RUN AT 8.984MHZ ON 8/24/87

ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CUT, THETA=90



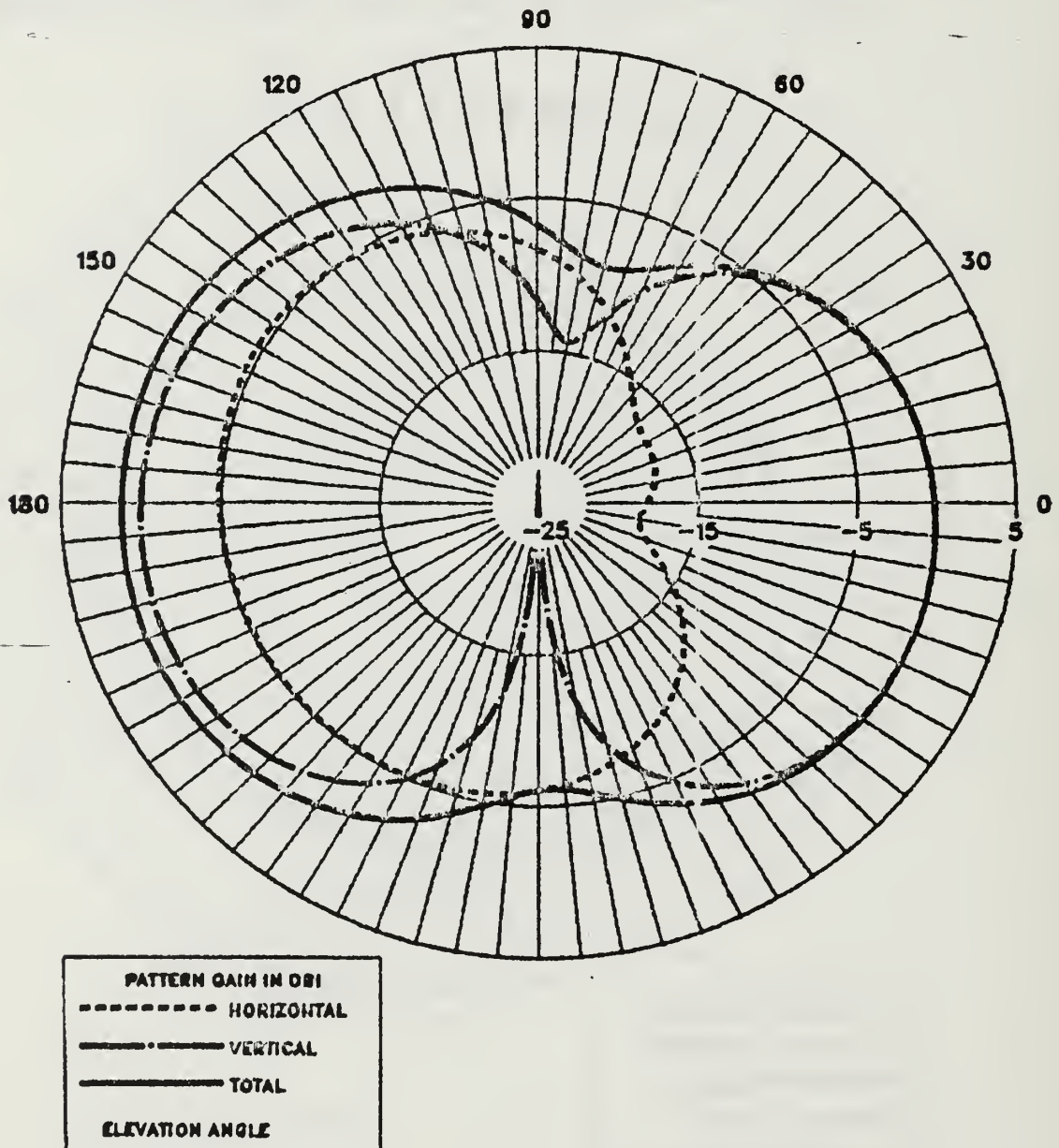
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ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CUT, THETA=26



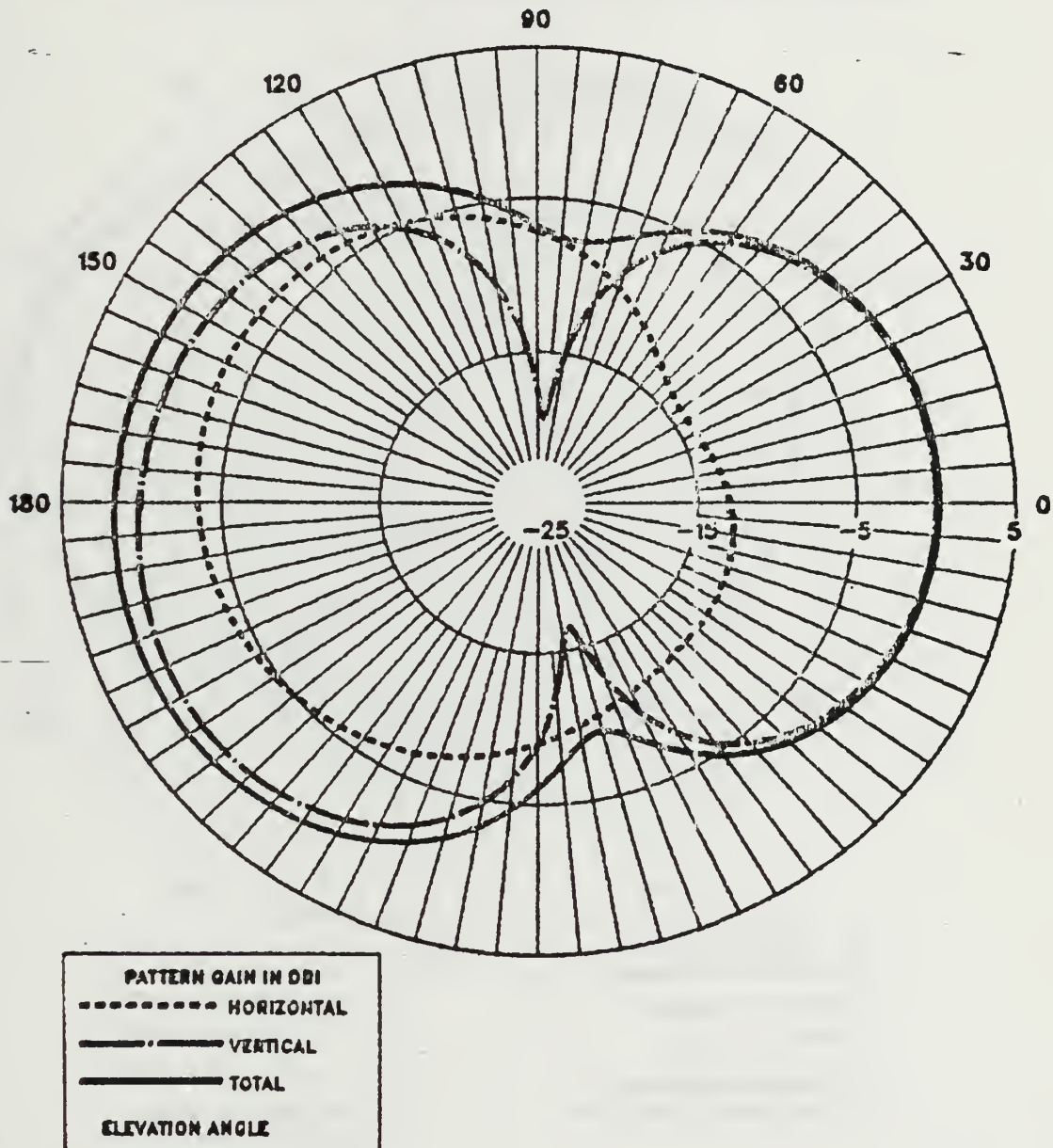
H60 IGUANA DATA RUN AT 8.984MHZ ON 8/24/87

ARMY-TYPE TUBE ANT, FREE SPACE, VERT CUT, PHI=0



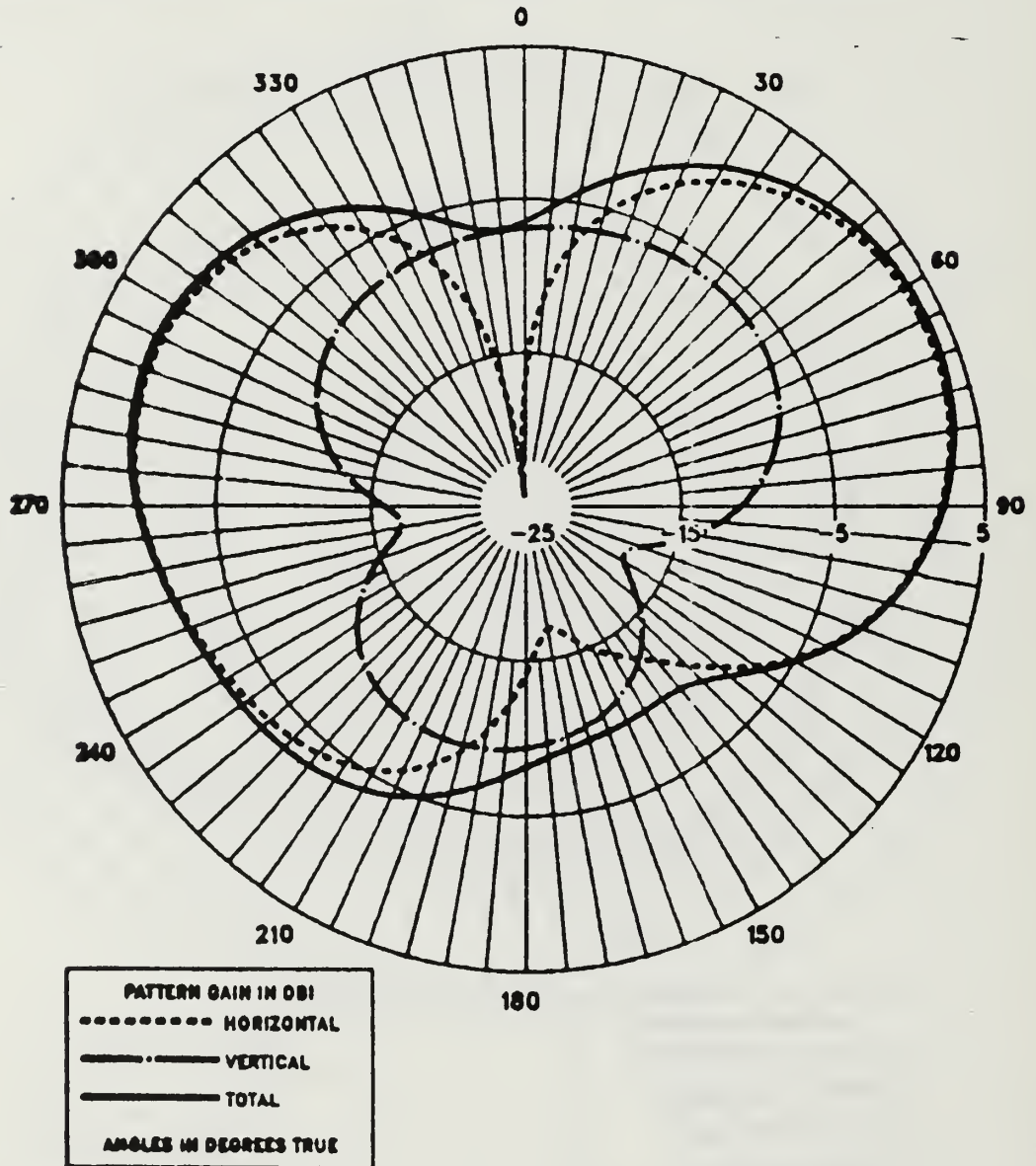
H65 IGUANA DATA RUN AT 8.984MHZ ON 8/24/87

ARMY-TYPE TUBE ANT, FREE SPACE, VERT CUT, PHI=45



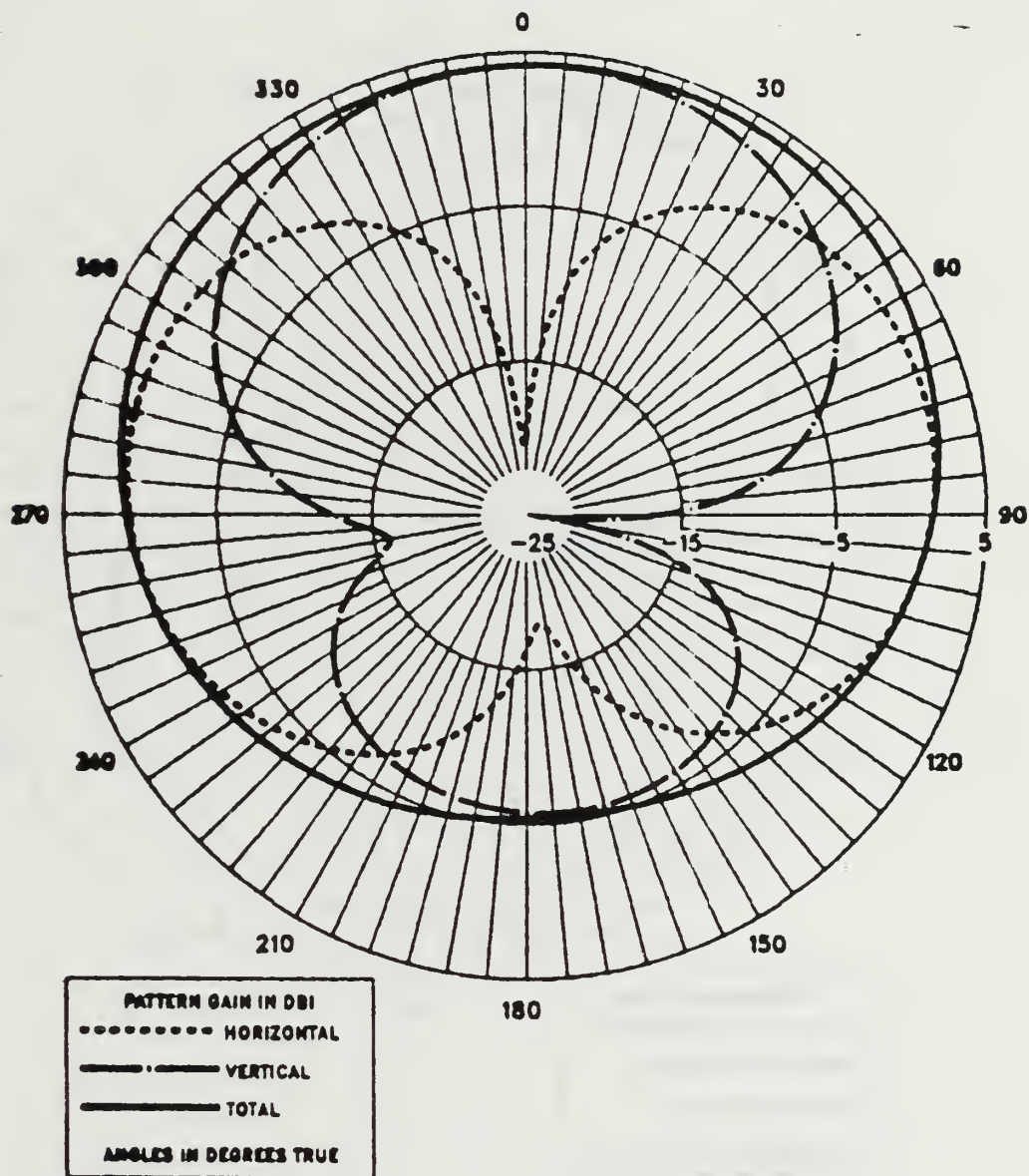
H60 IGUANA DATA RUN AT 13.974 MHZ ON 9/11/87

LONG-WIRE ANT, FREE SPACE, HORIZ CUT, THETA=90



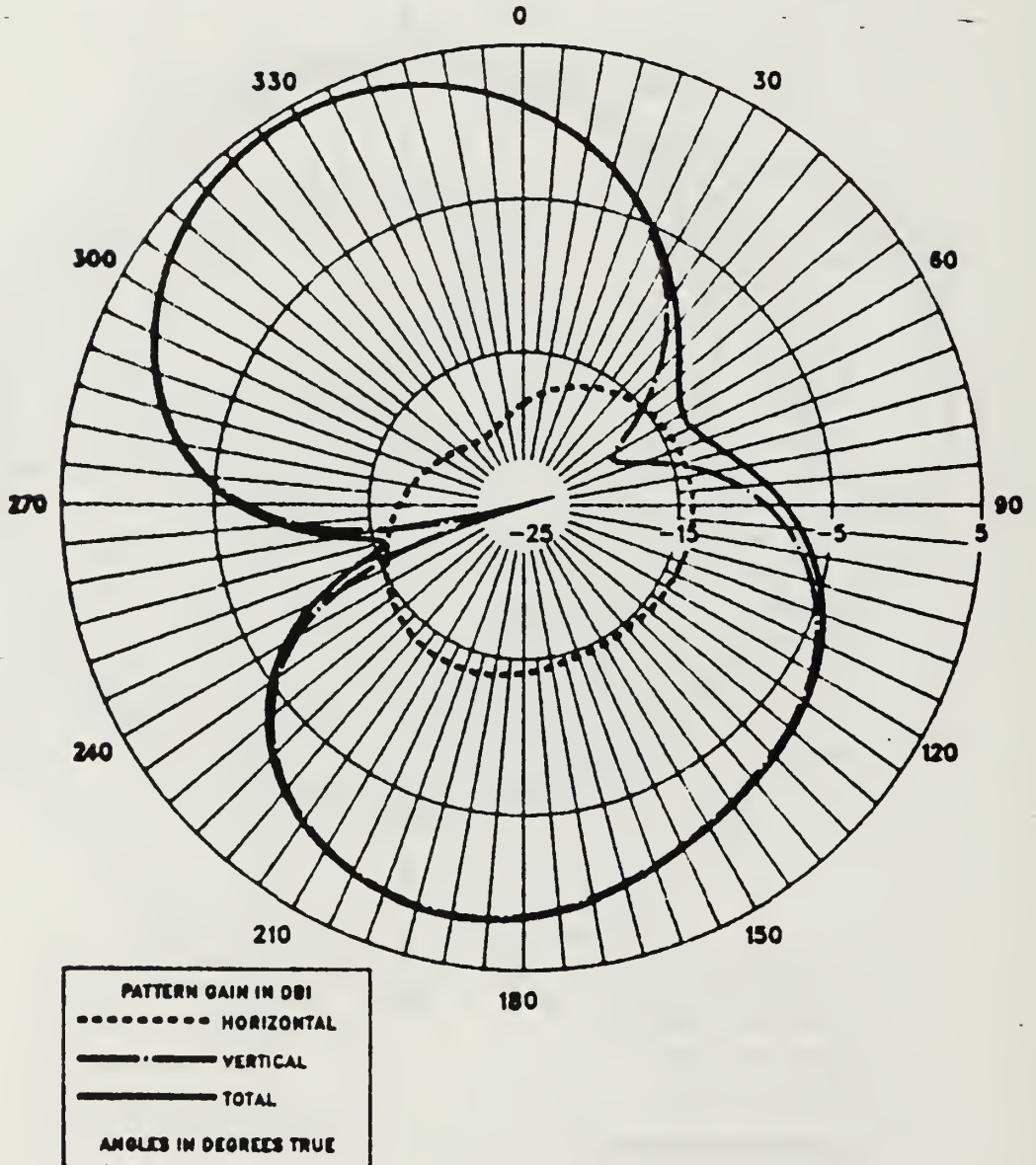
H60 IGUANA DATA RUN AT 13.974 MHZ ON 9/11/87

LONG-WIRE ANT, FREE SPACE, HORIZ CUT, THETA=26



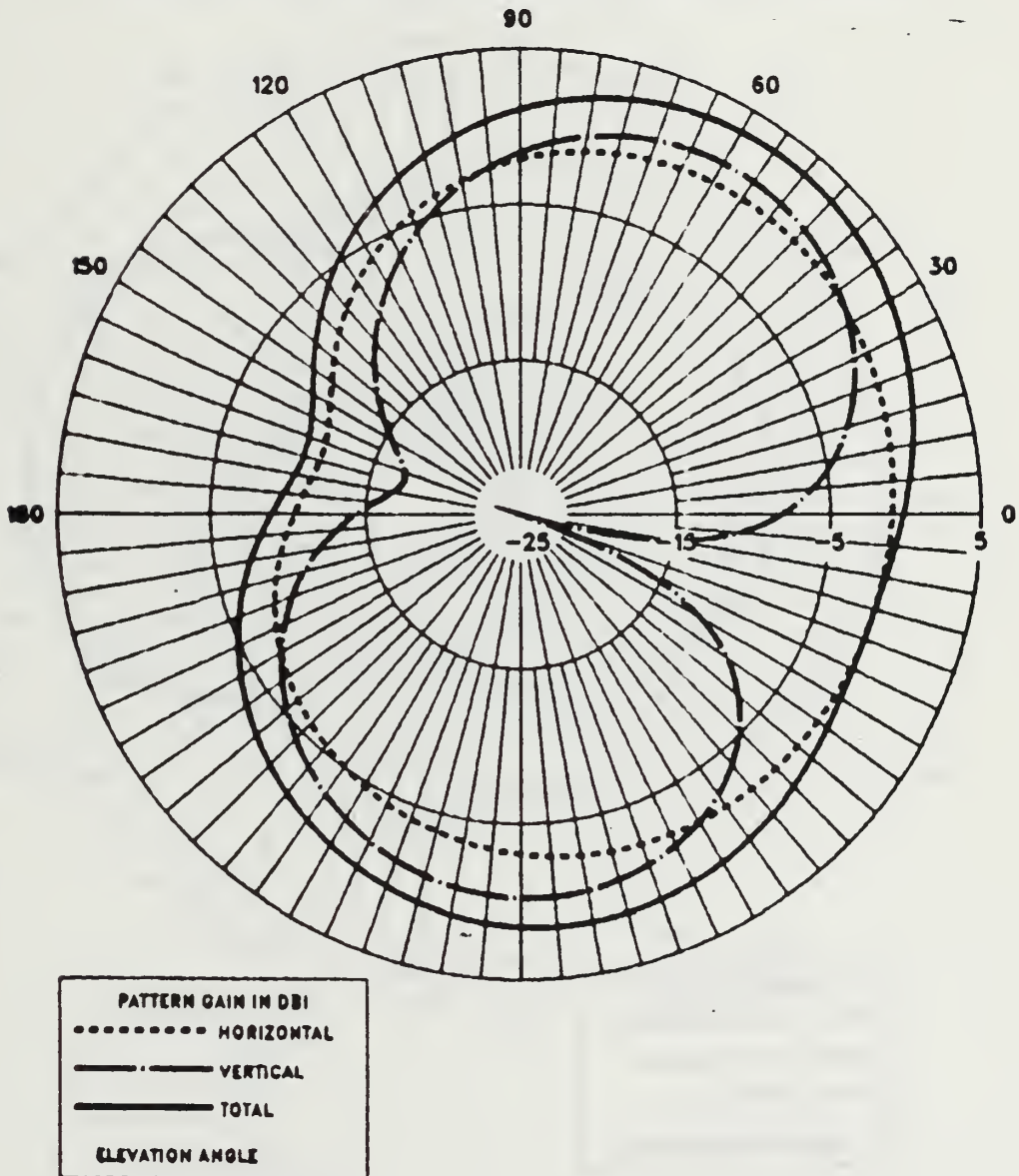
H60 IGUANA DATA RUN AT 13.974 MHZ ON 9/11/87

LONG-WIRE ANT, FREE SPACE, VERT CUT, PHI=0



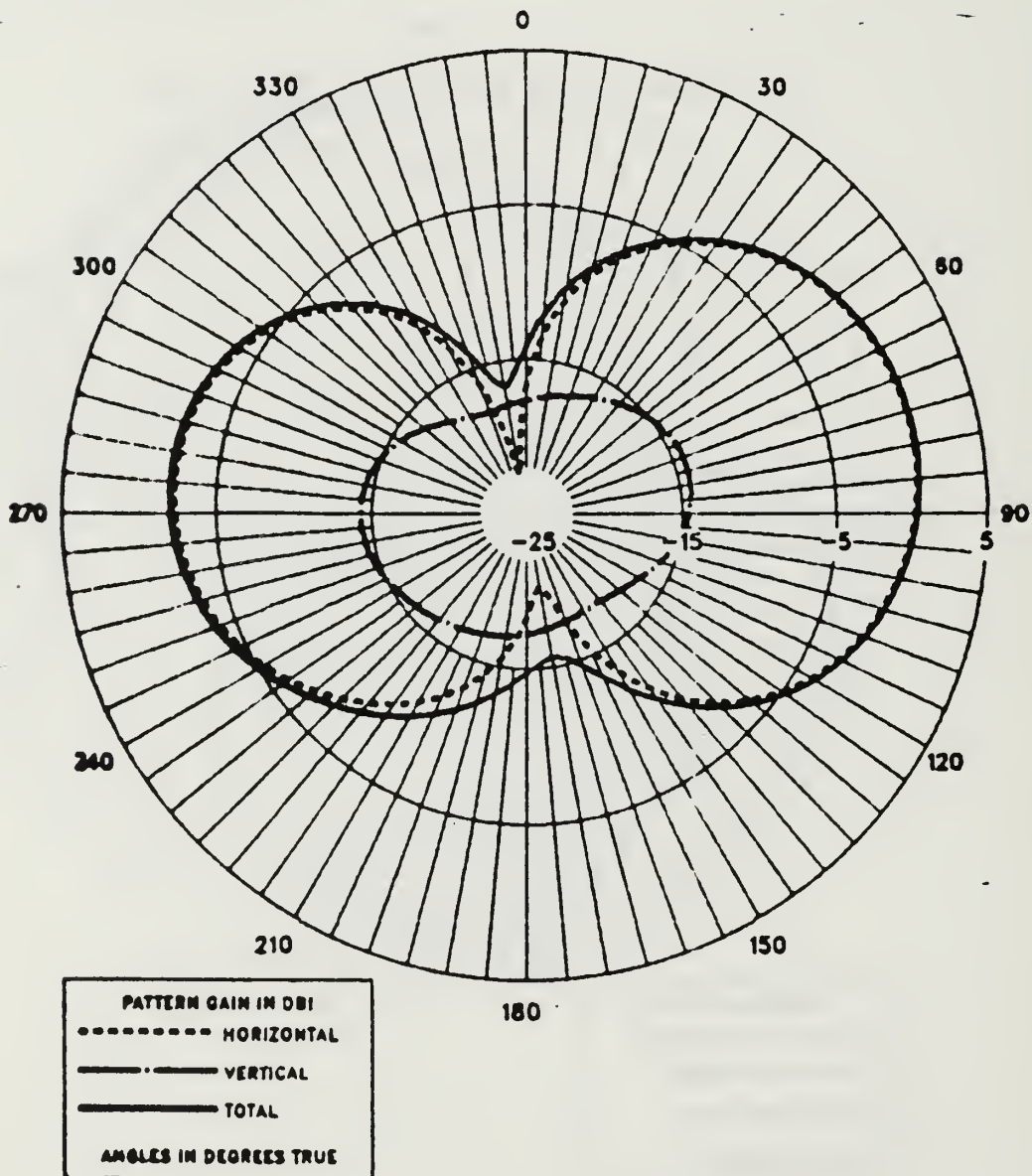
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LONG-WIRE ANT, FREE SPACE, VERT CUT, PHI=45



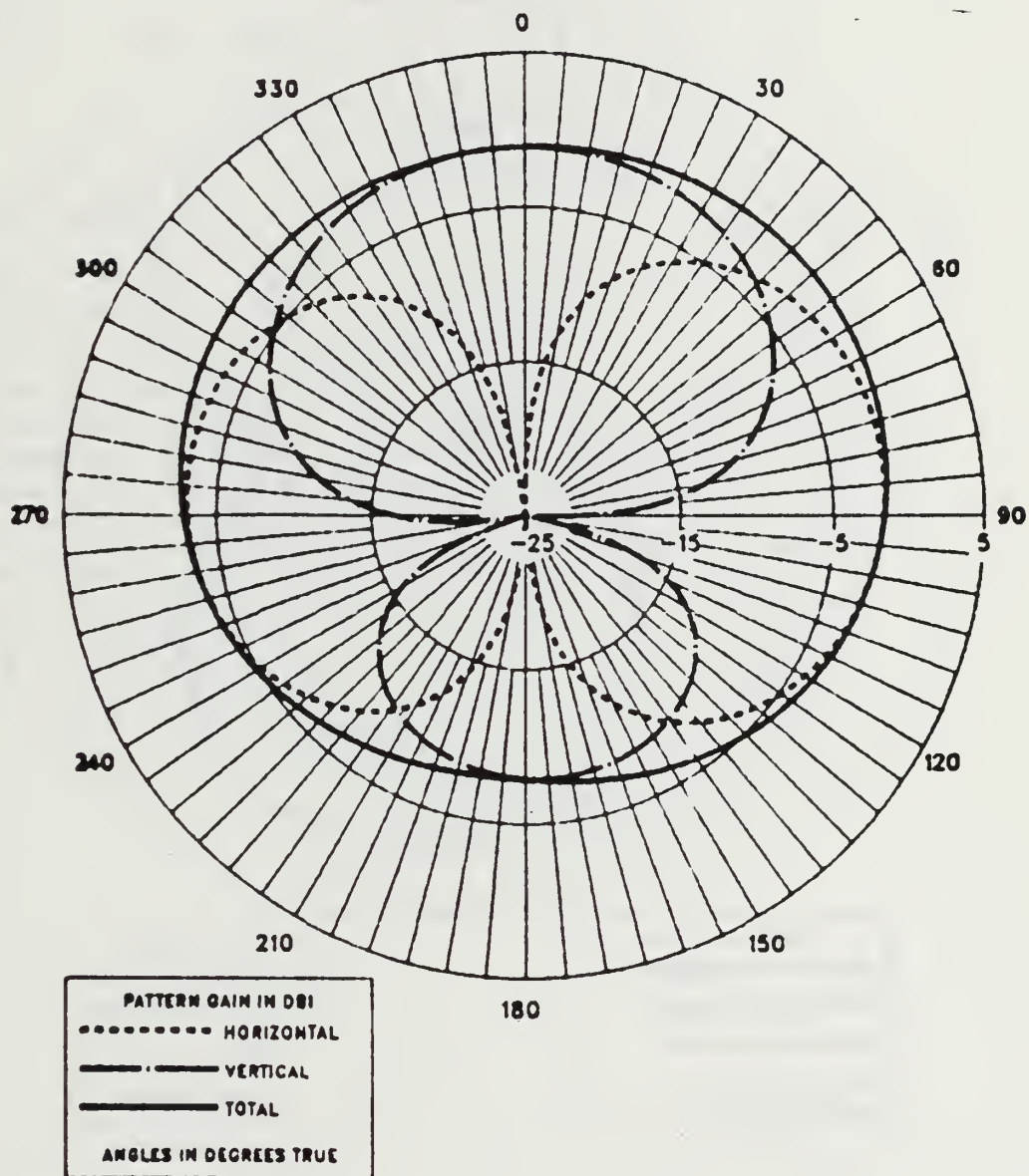
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NAVY 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=90



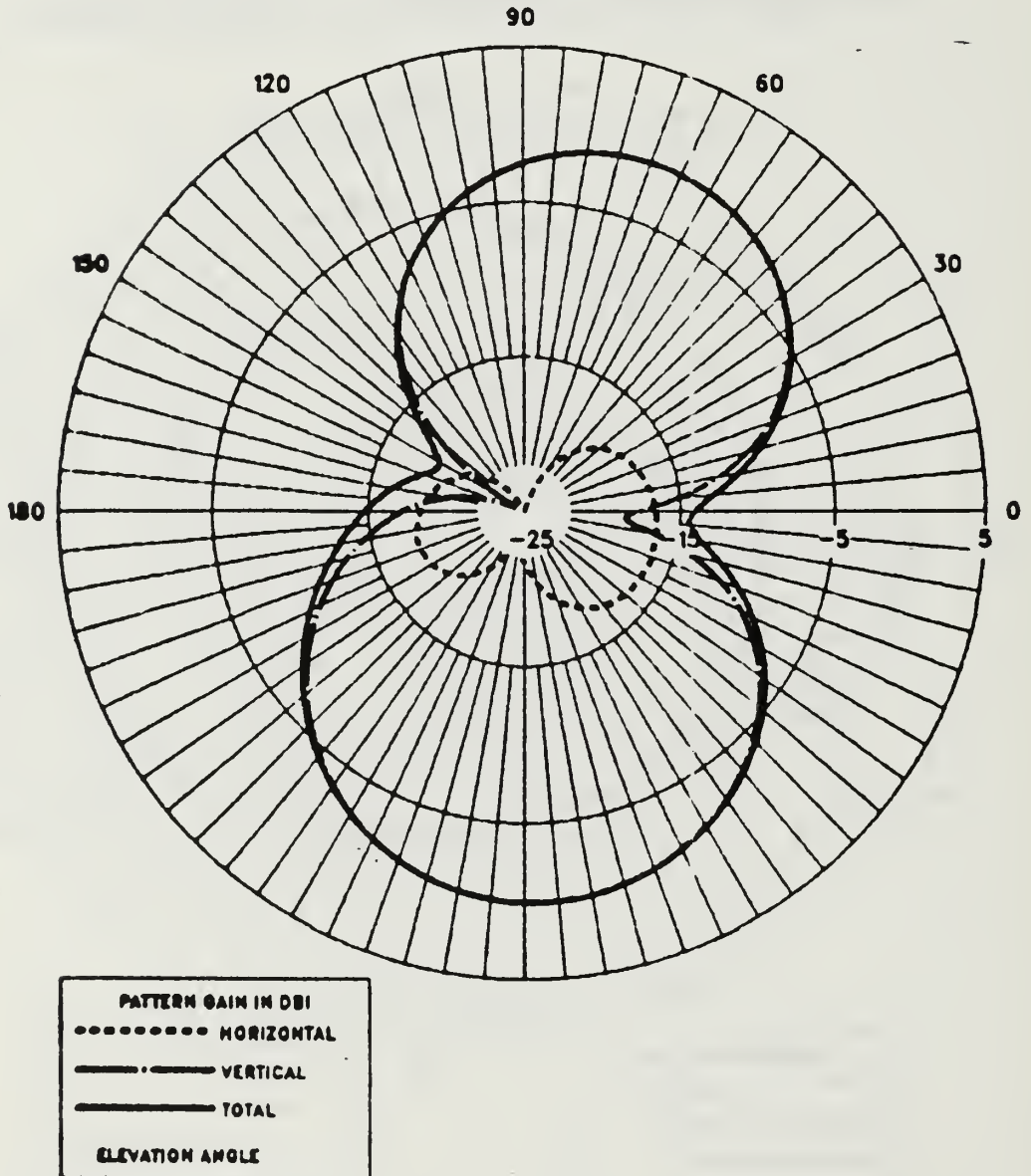
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NAVY 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=26



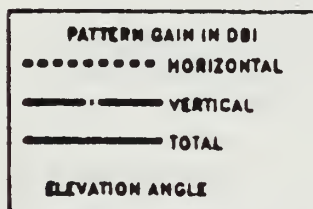
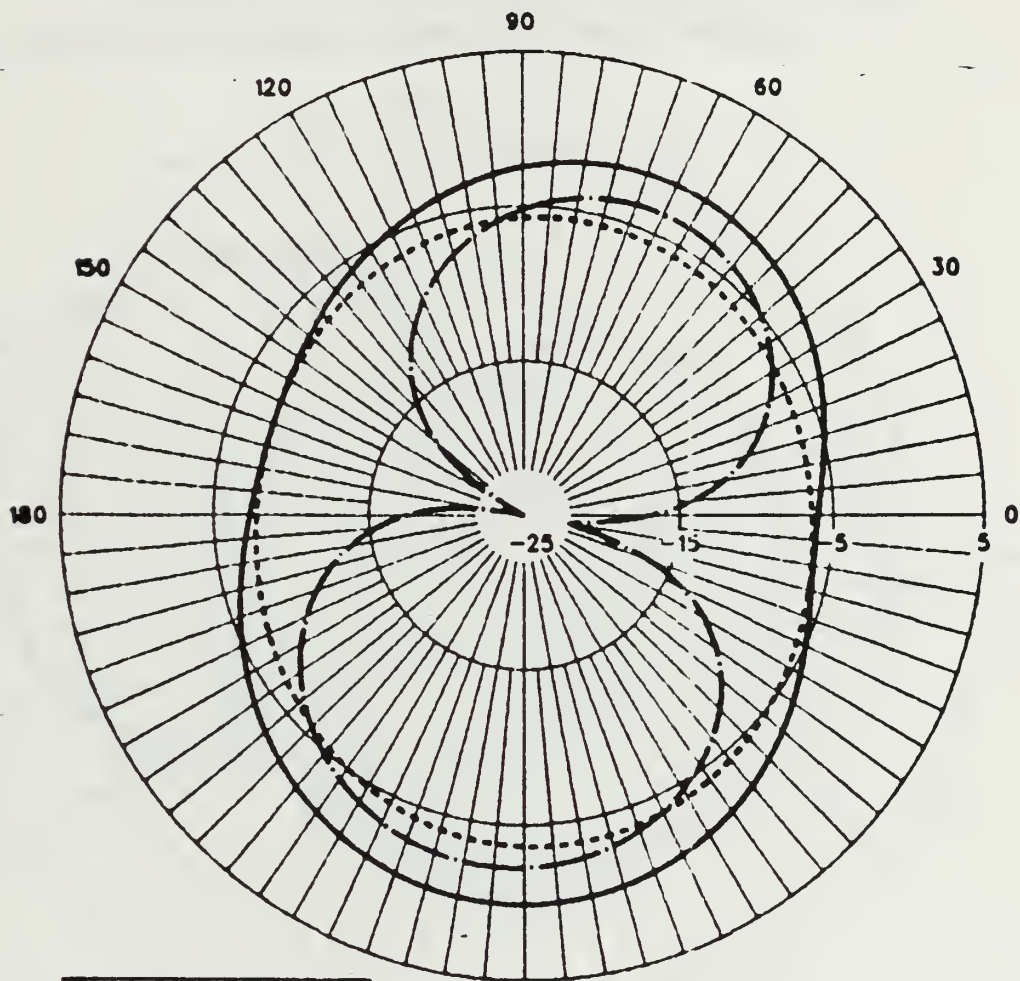
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NAVY 437R-2 ANT, FREE SPACE, VERT CUT, PHI=0



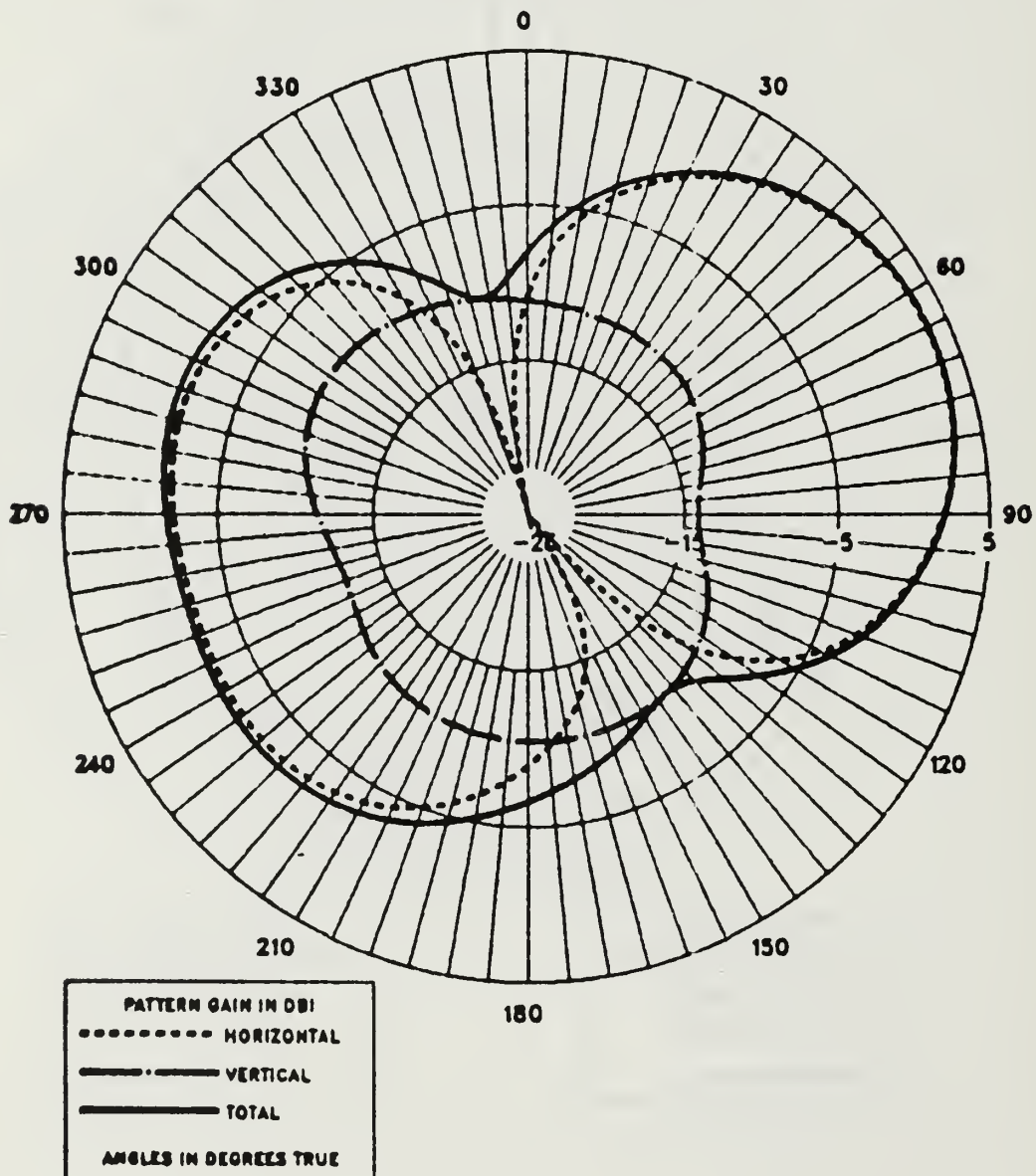
H60 IGUANA DATA RUN AT 13.974 MHZ ON 9/11/87

NAVY 437R-2 ANT, FREE SPACE, VERT CUT, PHI=45



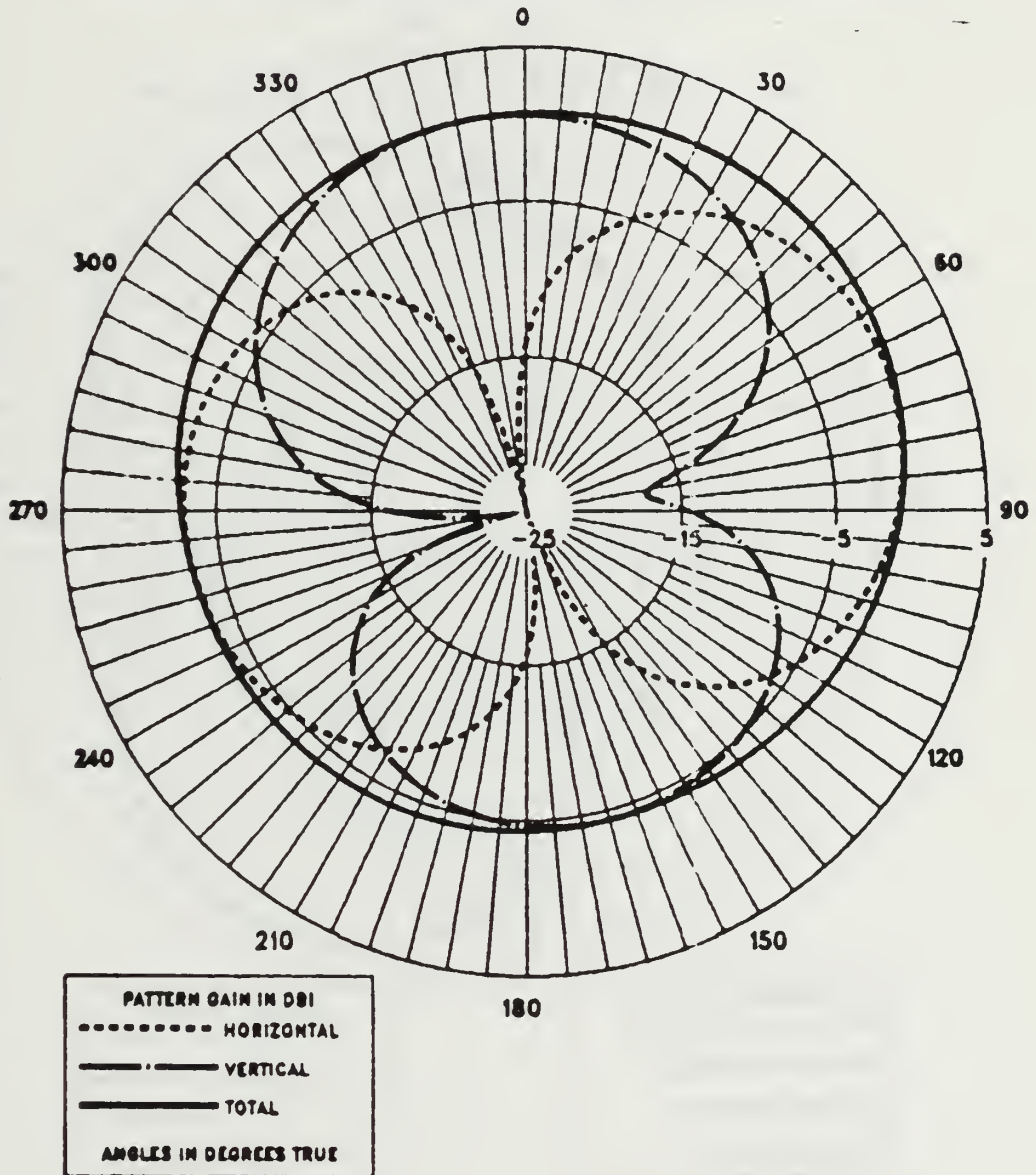
H60 IGUANA DATA RUN AT 13.974 MHZ ON 9/11/87

CG 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=90



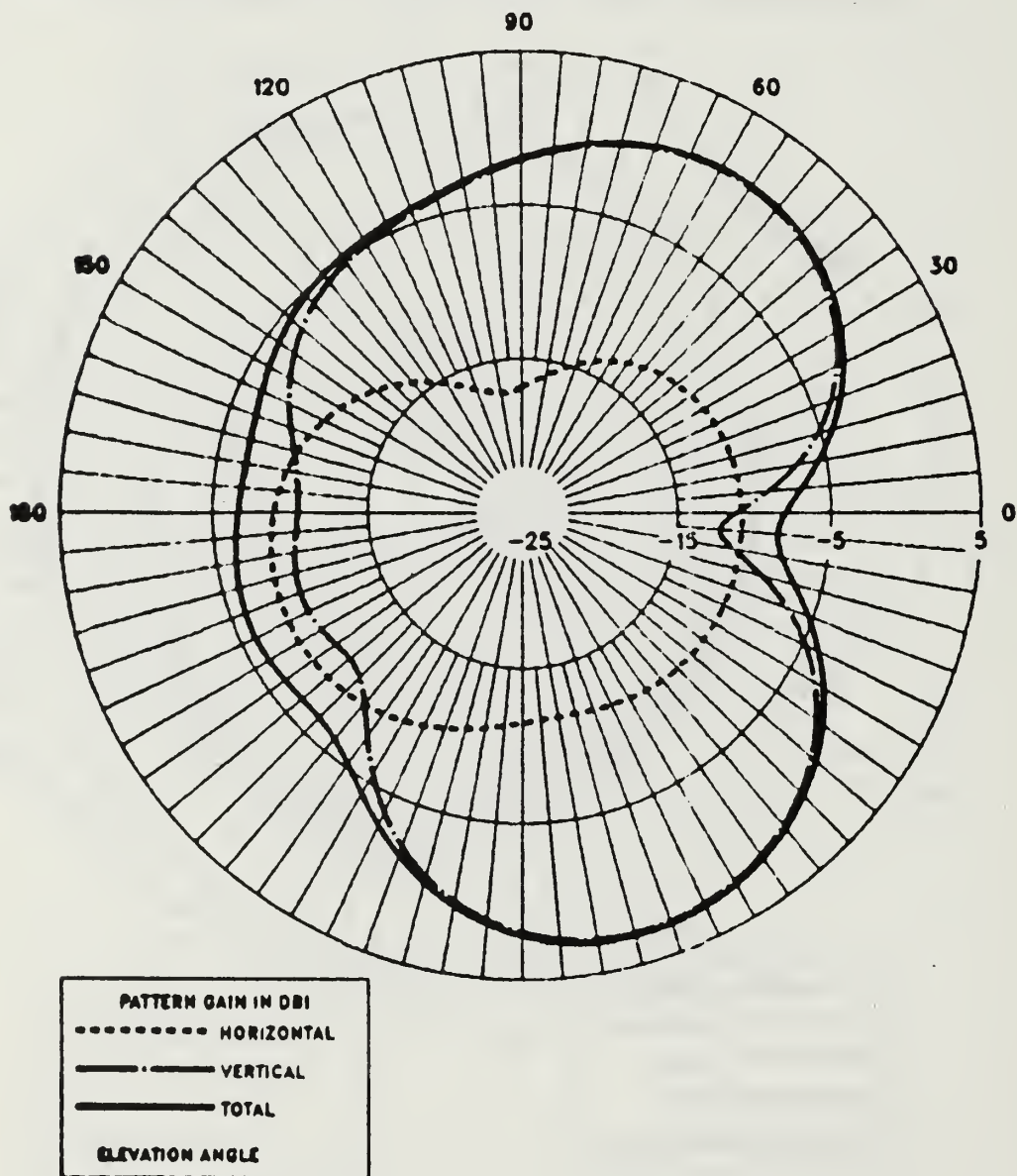
H60 IGUANA DATA RUN AT 13.974 MHZ ON 9/11/87

CG 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=26



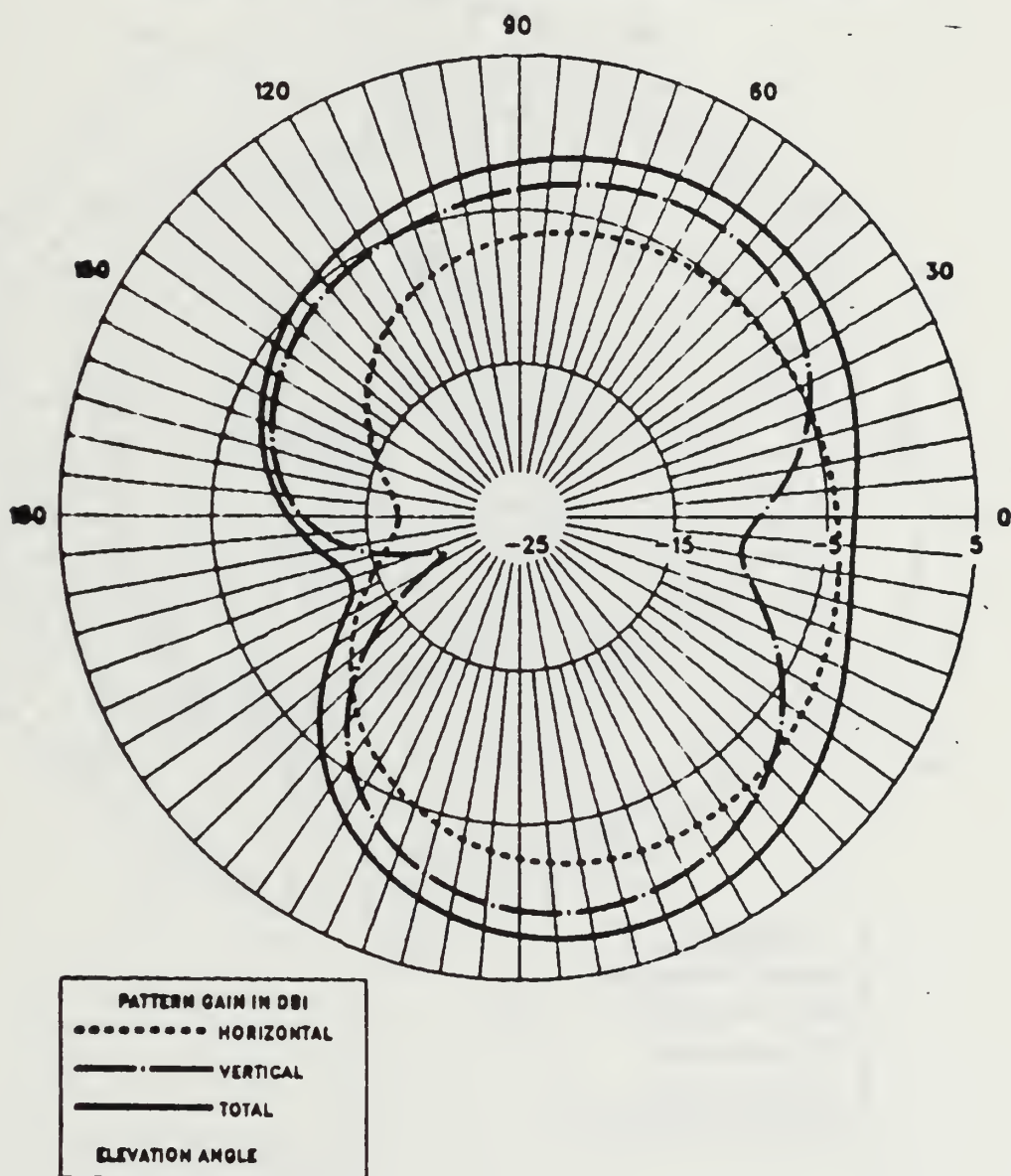
H60 IGUANA DATA RUN AT 13.974 MHZ ON 9/11/87

CG 437R-2 ANT, FREE SPACE, VERT CUT, PHI=0



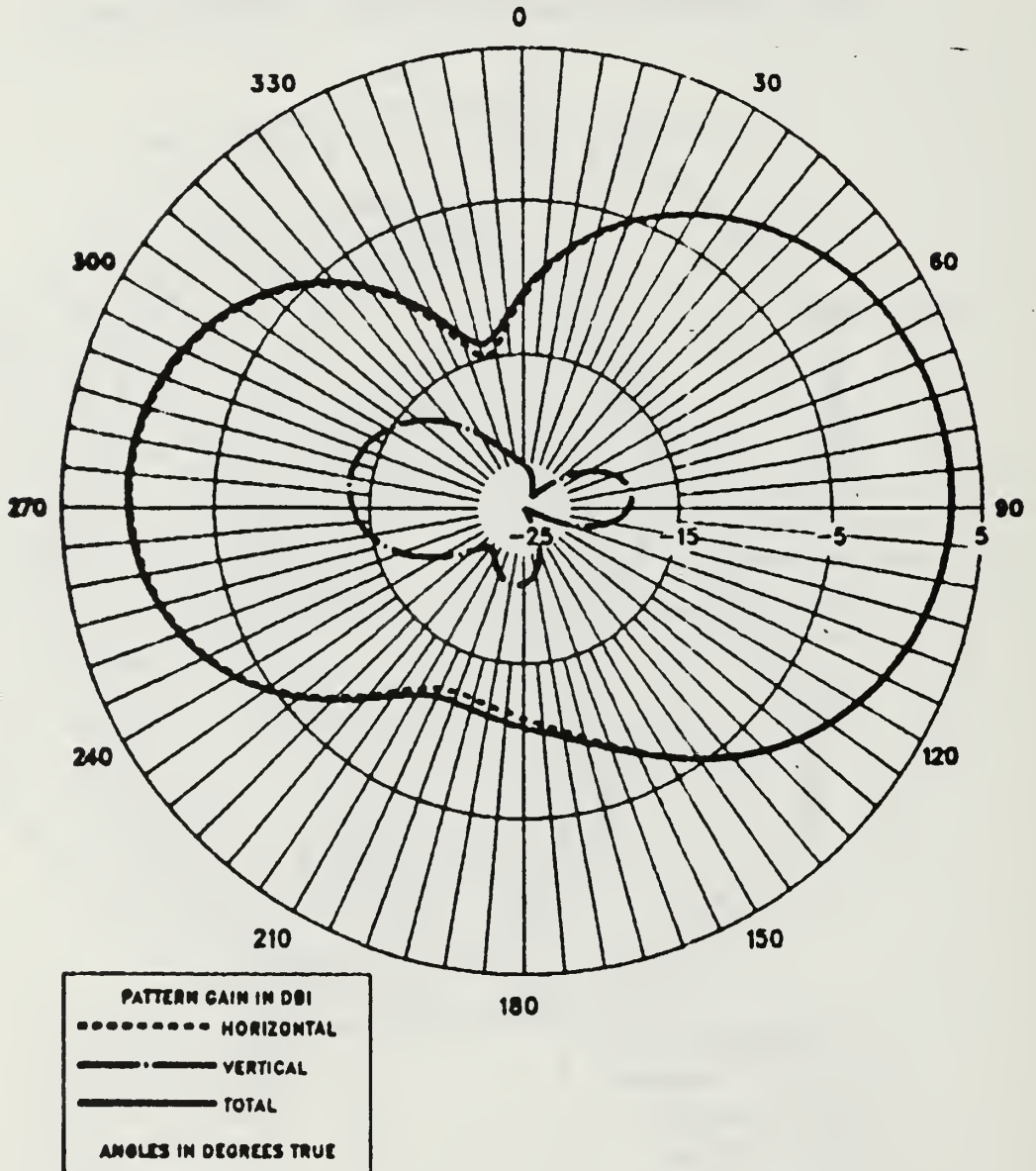
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CG 437R-2 ANT, FREE SPACE, VERT CUT, PHI=45



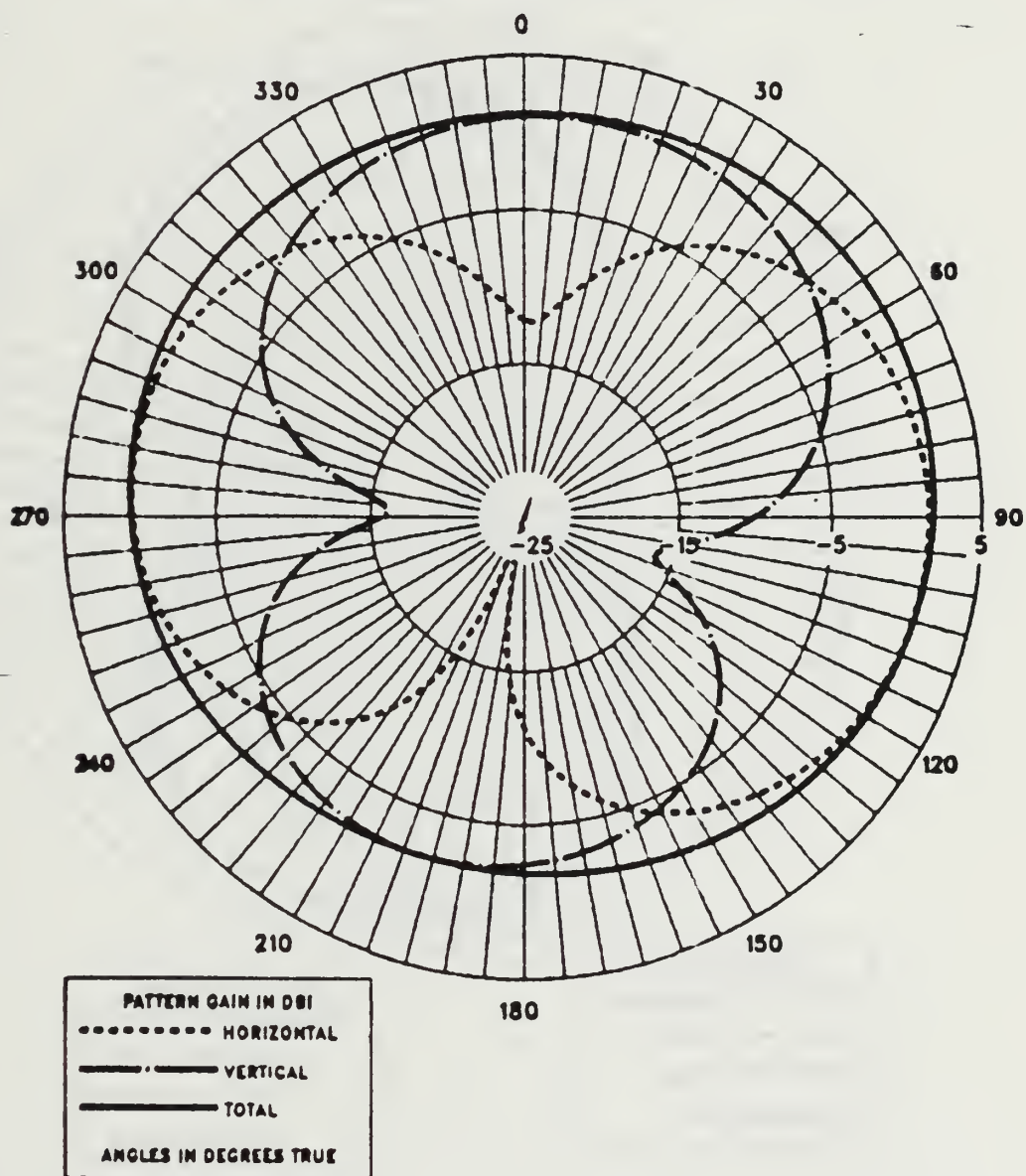
H60 IGUANA DATA RUN AT 13.974 MHZ ON 9/11/87

ARMY TUBE ANT, FREE SPACE, HORIZ CUT, THETA=90



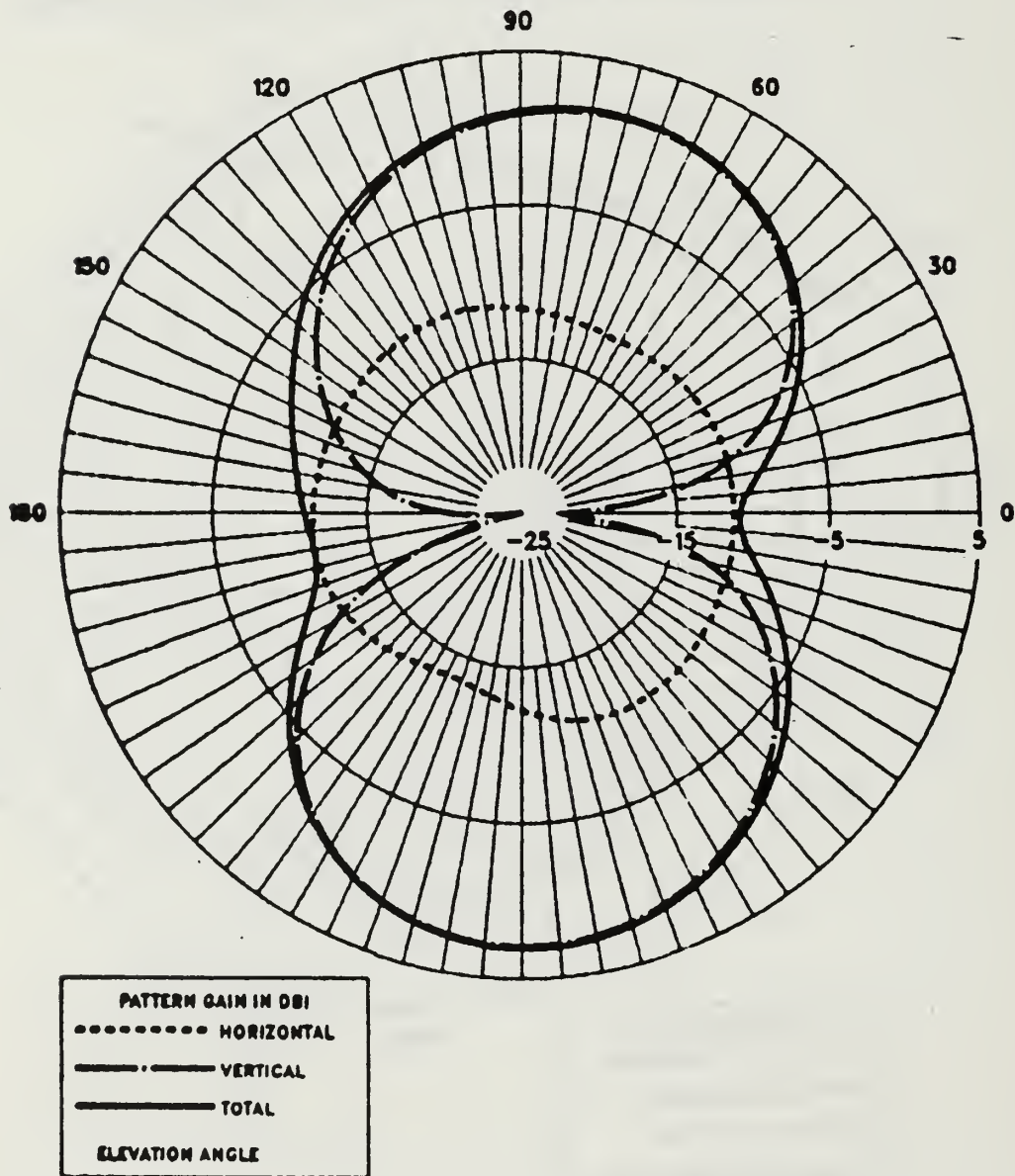
H60 IGUANA DATA RUN AT 13.974 MHZ ON 9/11/87

ARMY TUBE ANT, FREE SPACE, HORIZ CUT, THETA=26



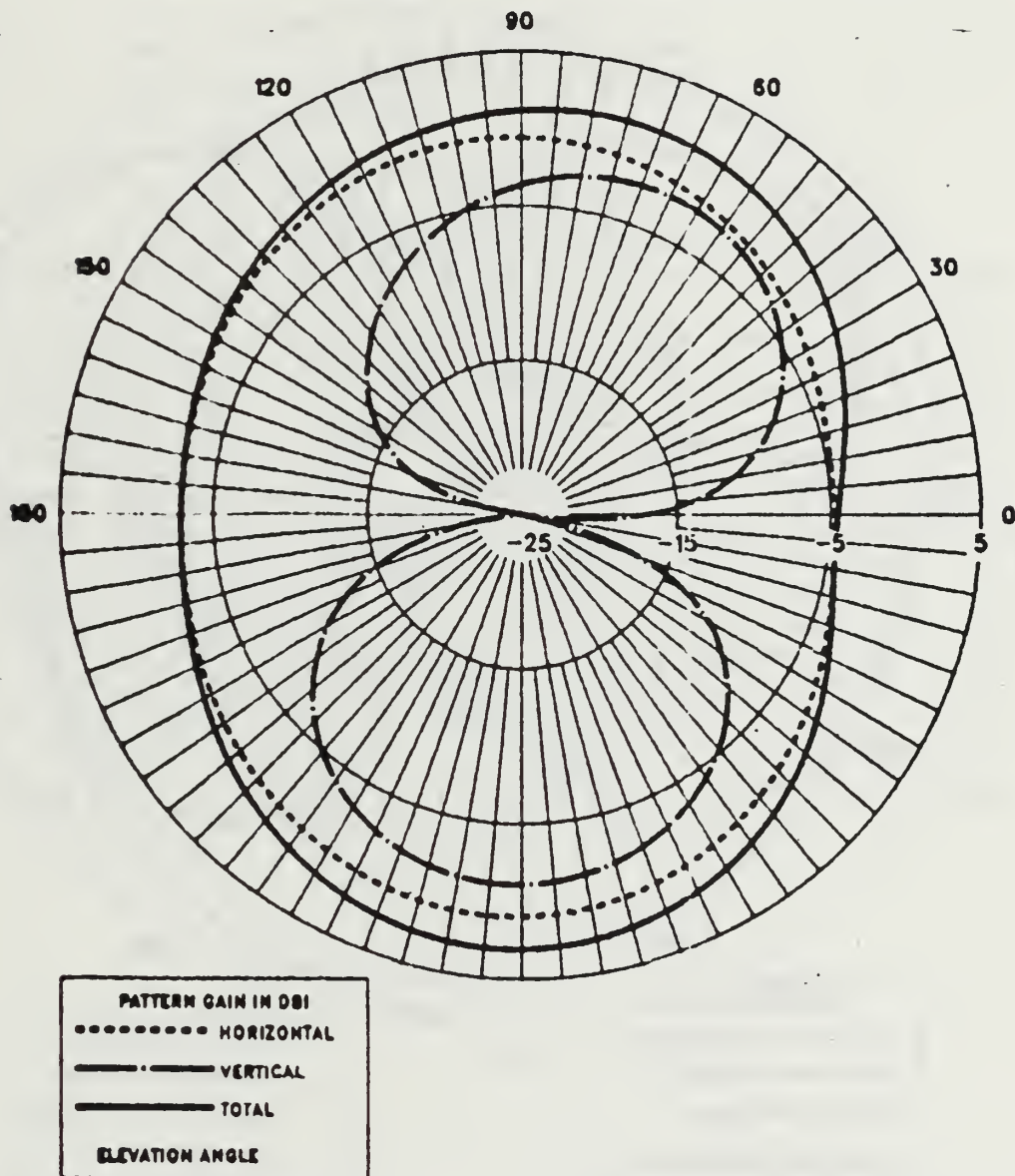
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ARMY TUBE ANT, FREE SPACE, VERT CUT, $\Phi=0$



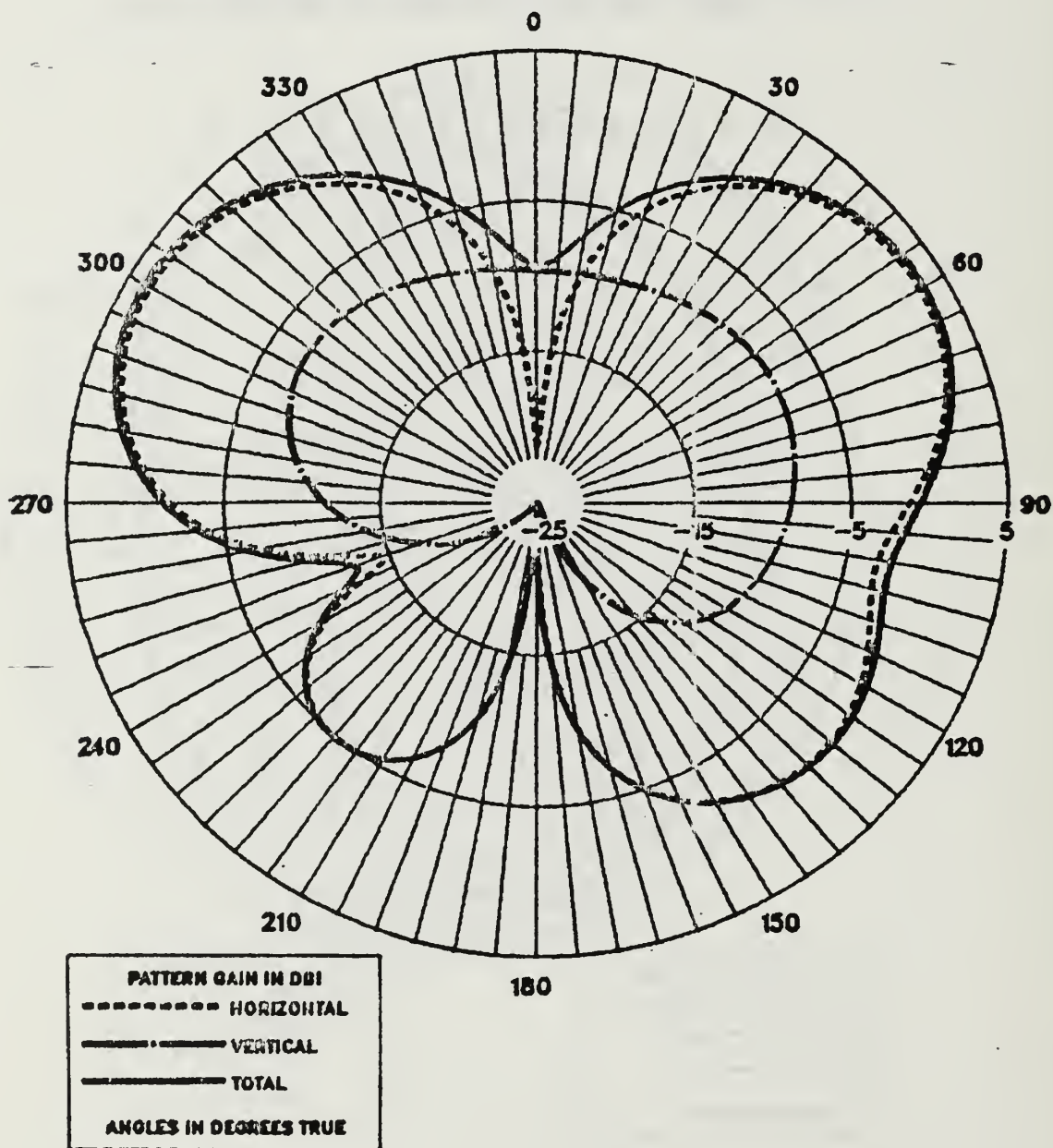
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ARMY TUBE ANT, FREE SPACE, VERT CUT, PHI=45



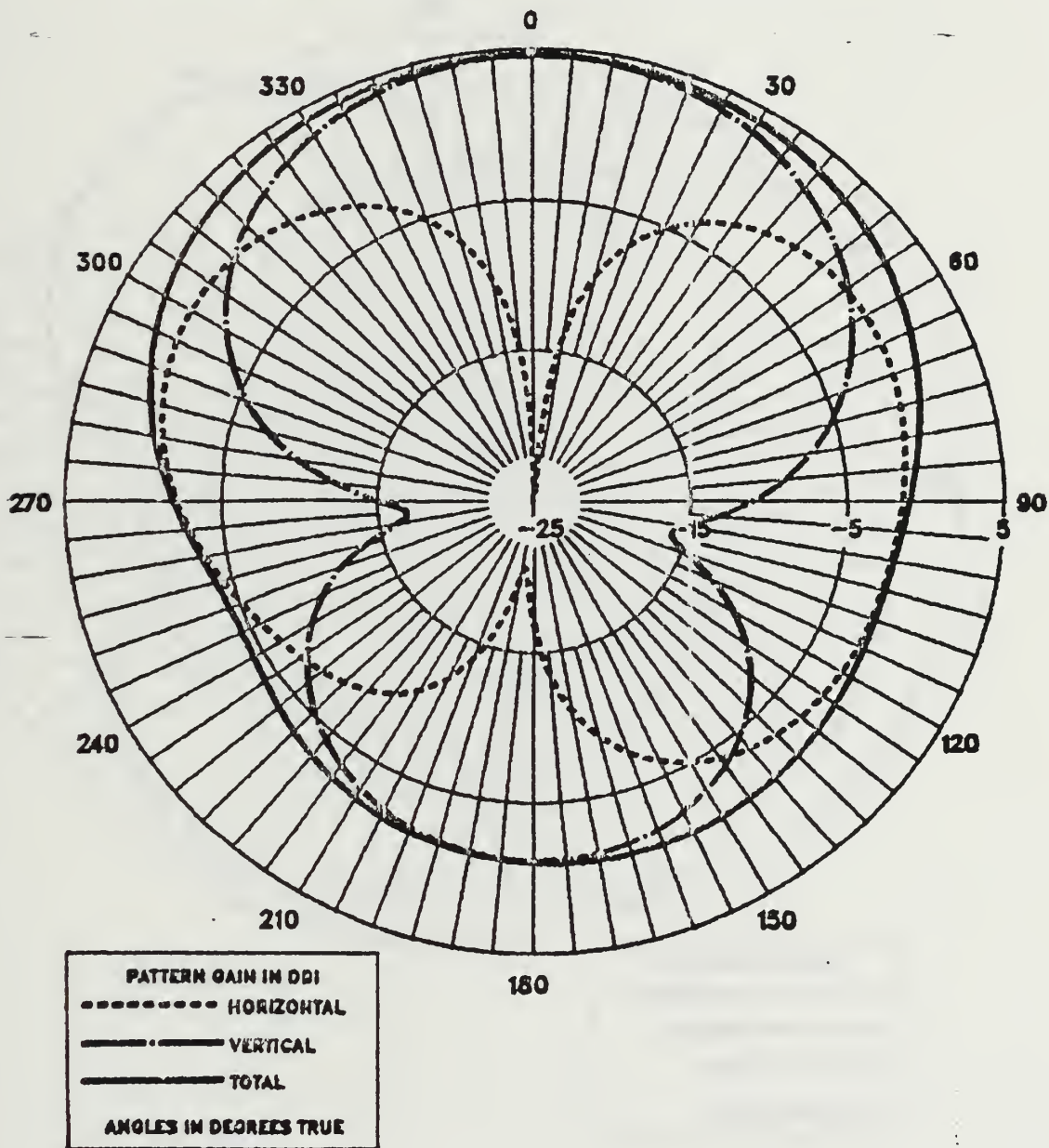
H60 IGUANA DATA RUN AT 18.1MHZ ON 8/22/87

LONG-WIRE ANT, FREE SPACE, HORIZ CUT, THETA=90



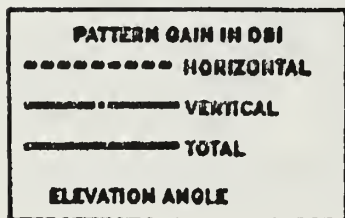
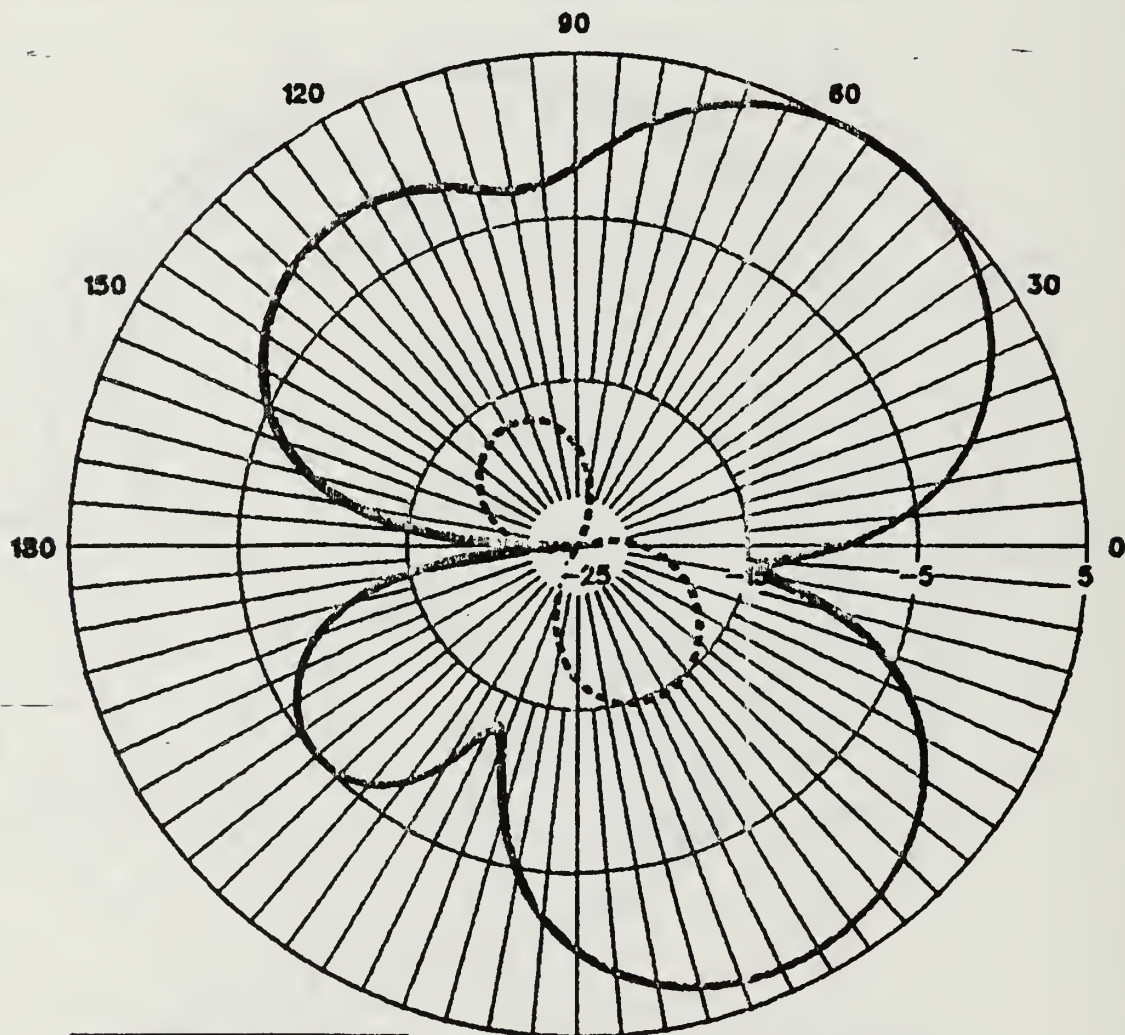
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LONG-WIRE ANT, FREE SPACE, HORIZ CUT, THETA=26



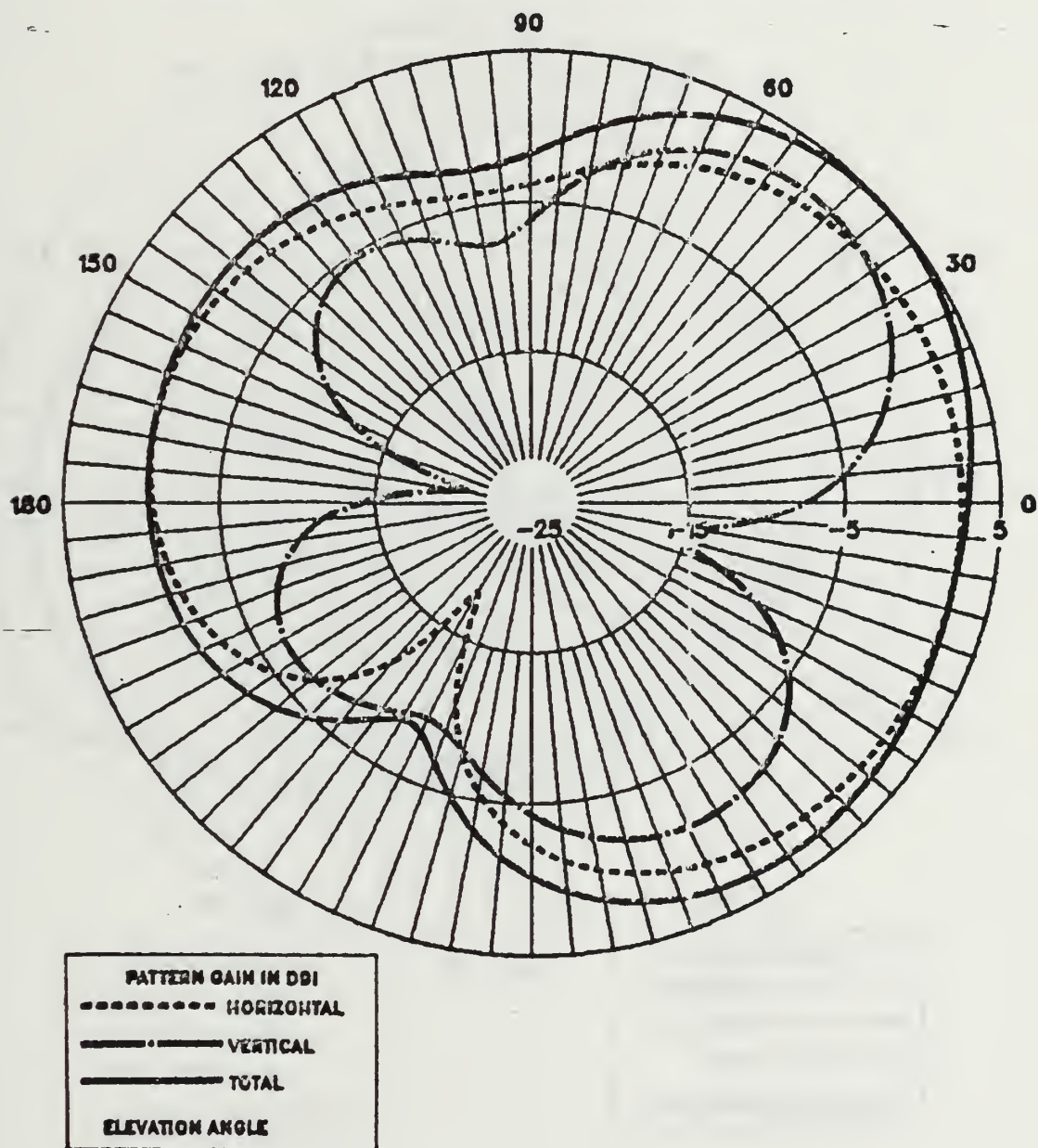
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LONG-WIRE ANT, FREE SPACE, VERT CUT, PHI=0



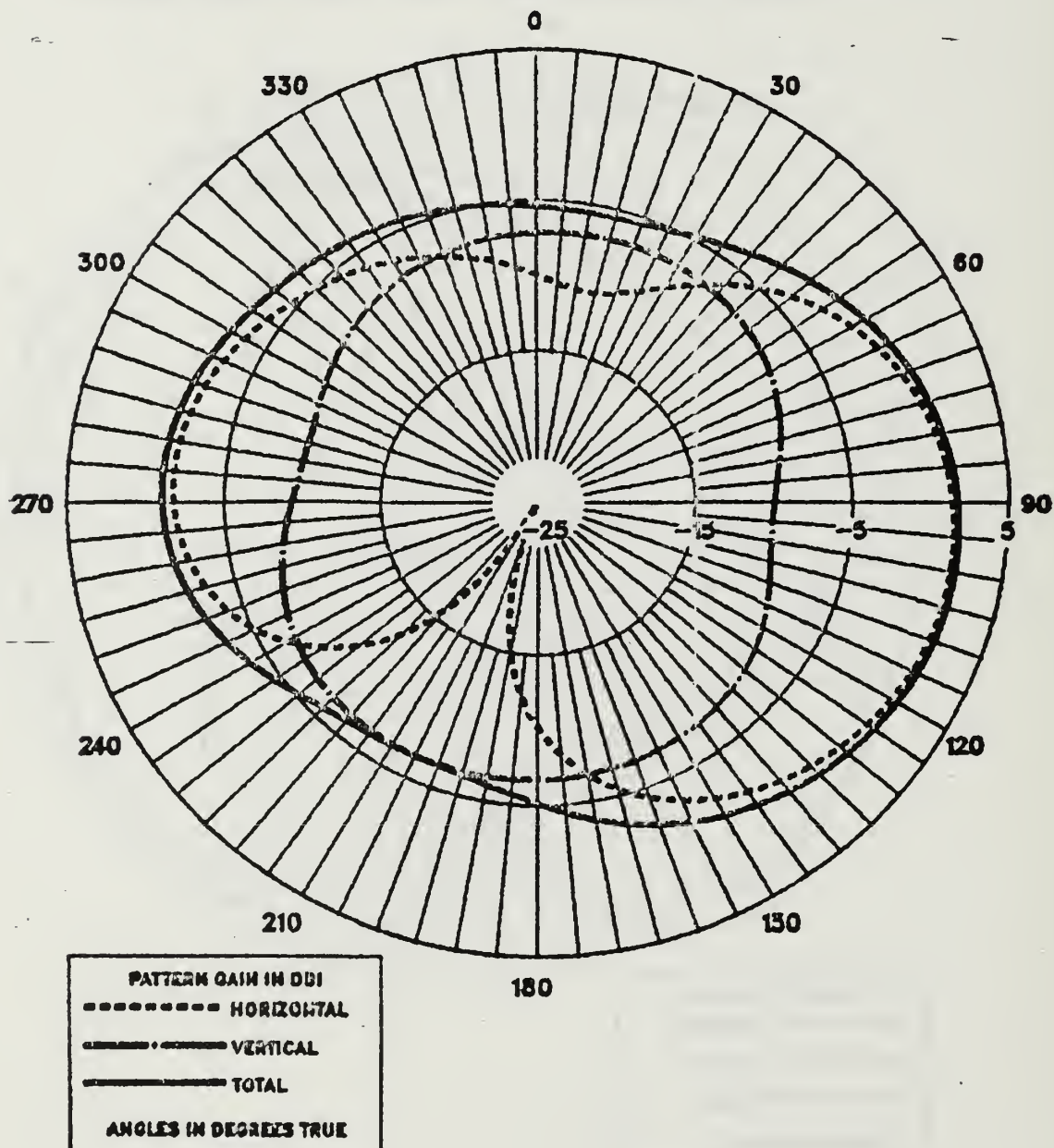
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LONG-WIRE ANT, FREE SPACE, VERT CUT, PHI=45



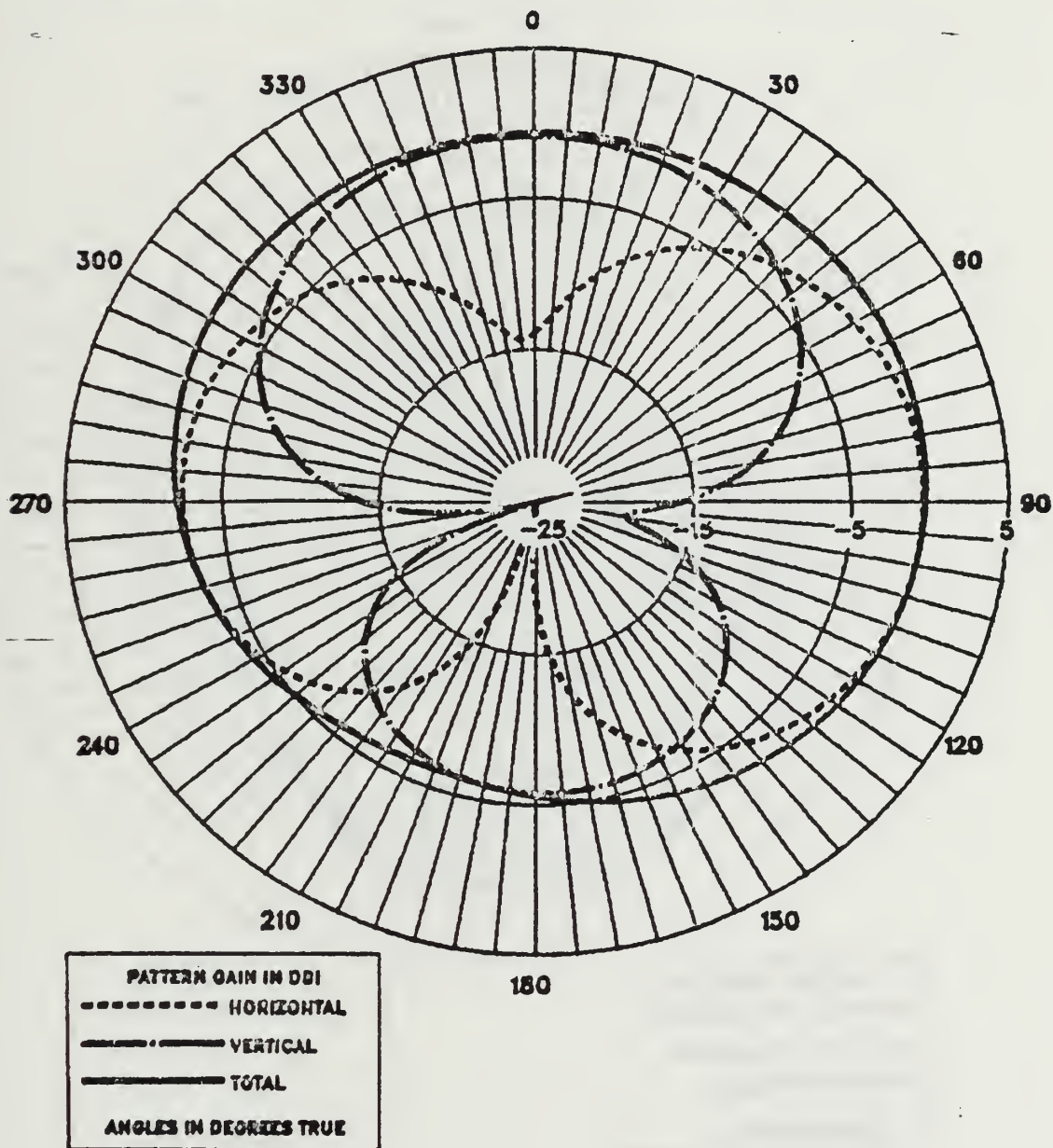
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NAVY 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=90



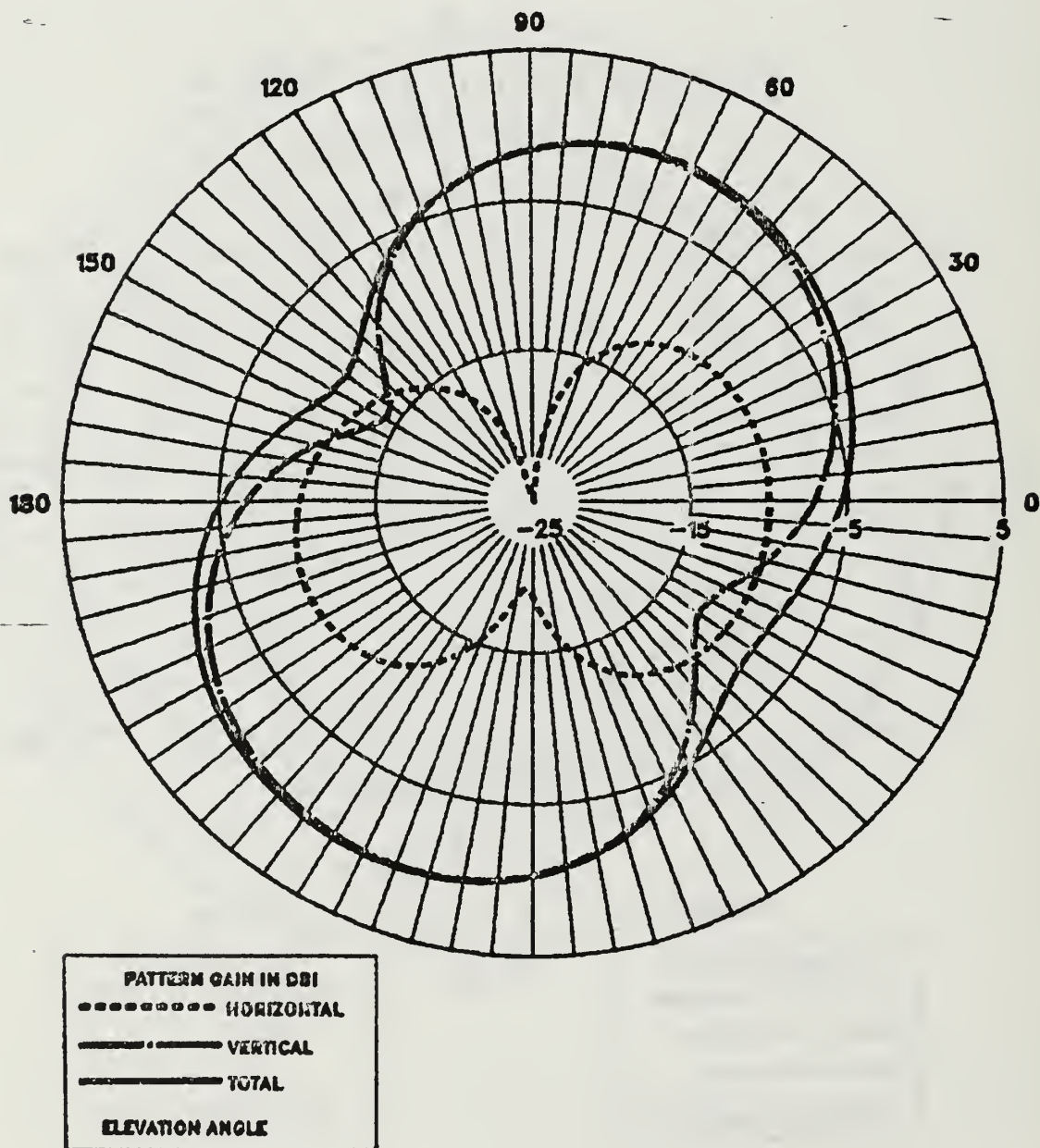
H60 IGUANA DATA RUN AT 18.1MHZ ON 8/22/87

NAVY 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=26



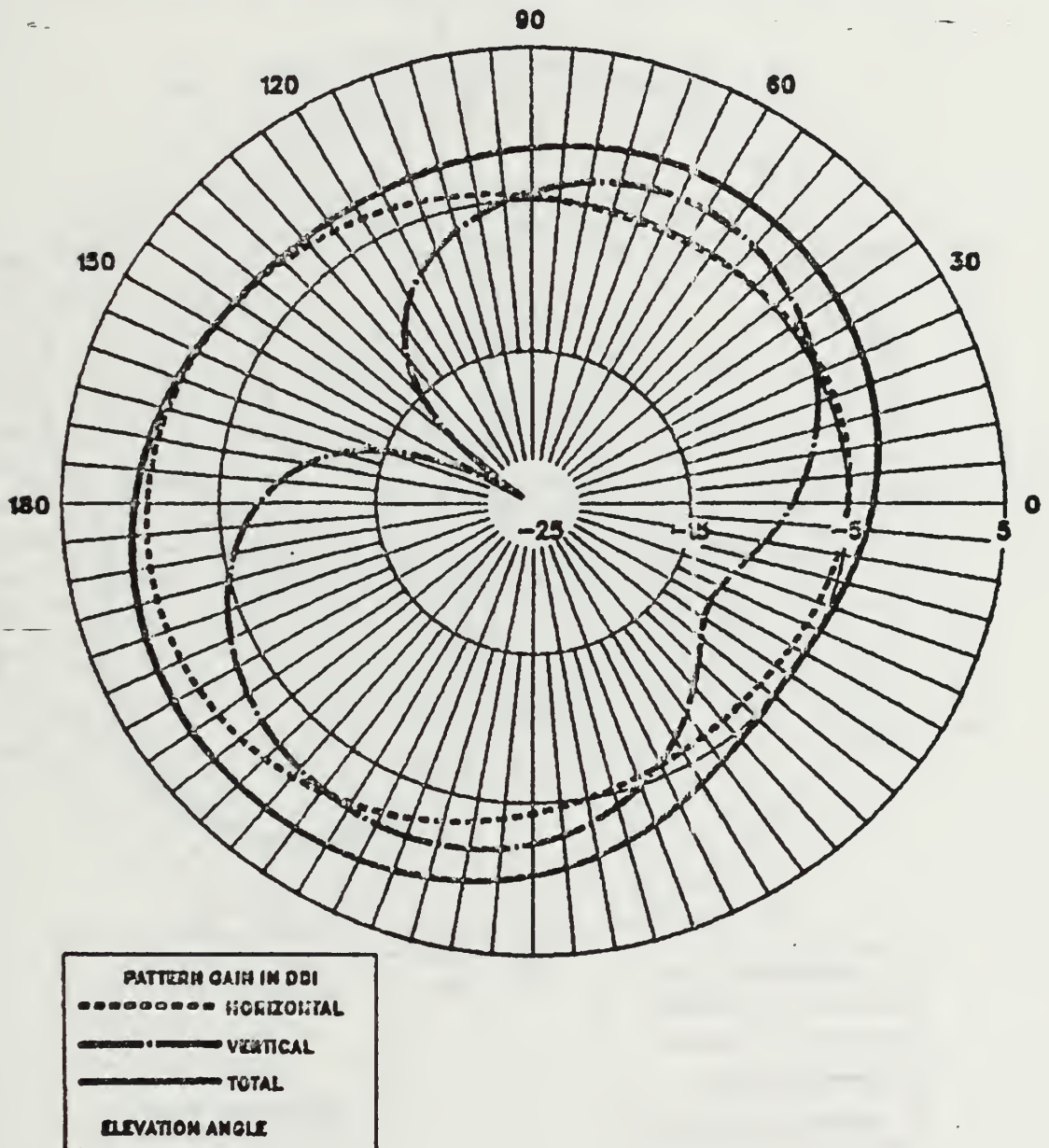
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NAVY 437R-2 ANT, FREE SPACE, VERT CUT, PHI=0



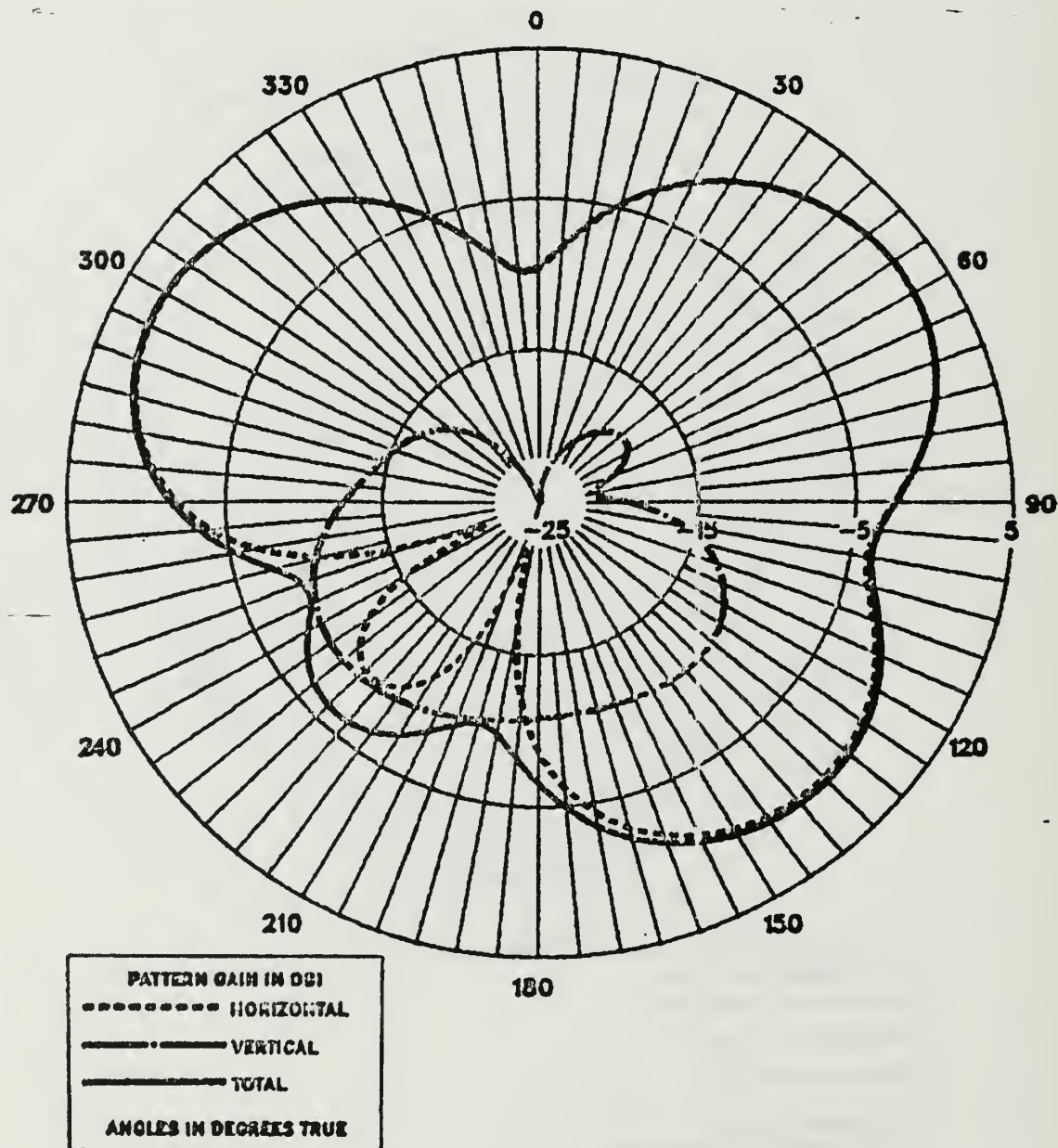
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NAVY 437R-2 ANT, FREE SPACE, VERT CUT, $\Phi=45$



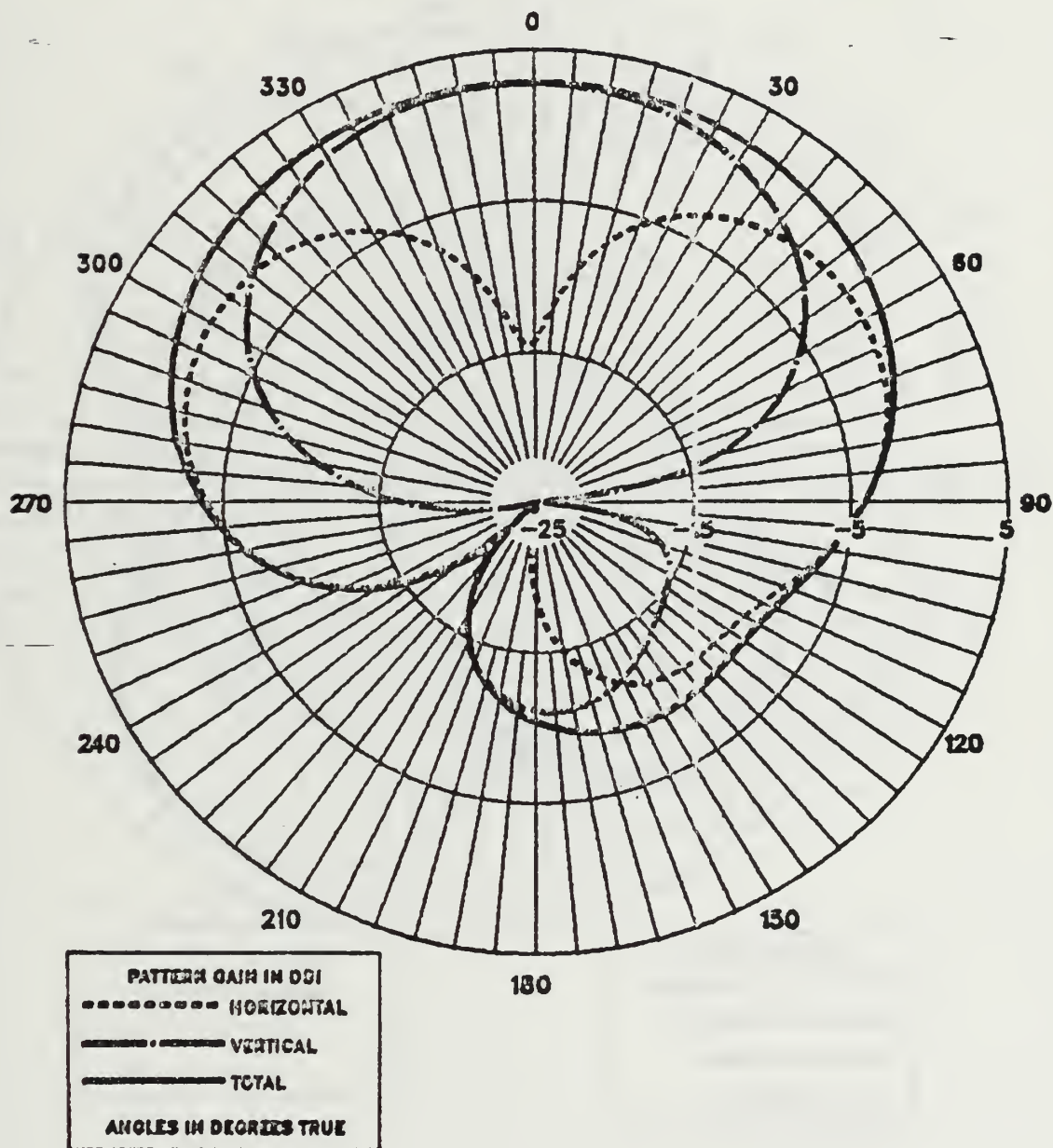
H60 IGUANA DATA RUN AT 18.1MHZ ON 8/22/87

CG 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=90



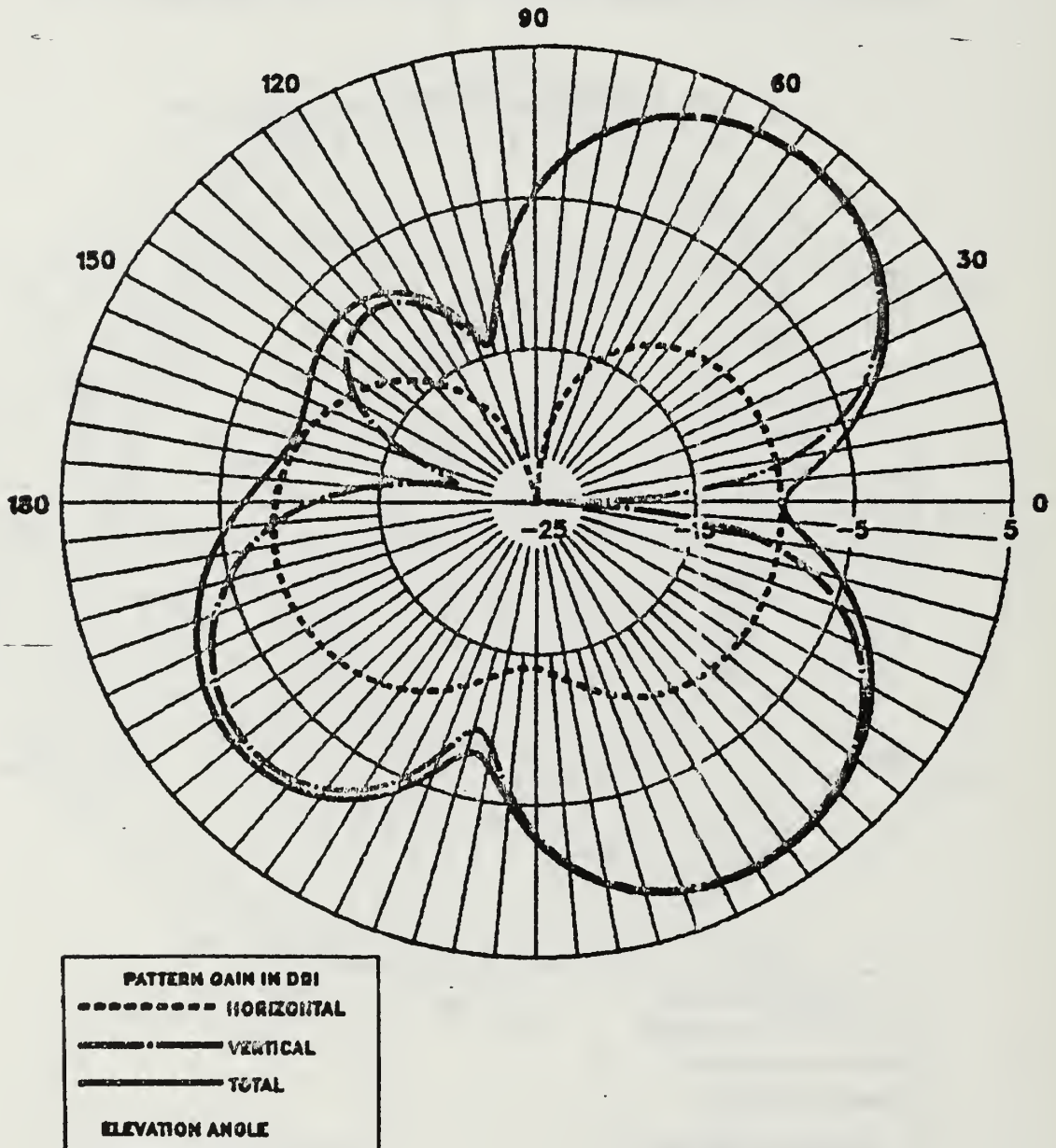
H60 IGUANA DATA RUN AT 18.1MHZ ON 8/22/87

CG 437R-2 ANT, FREE SPACE, HORIZ CUT, THETA=26



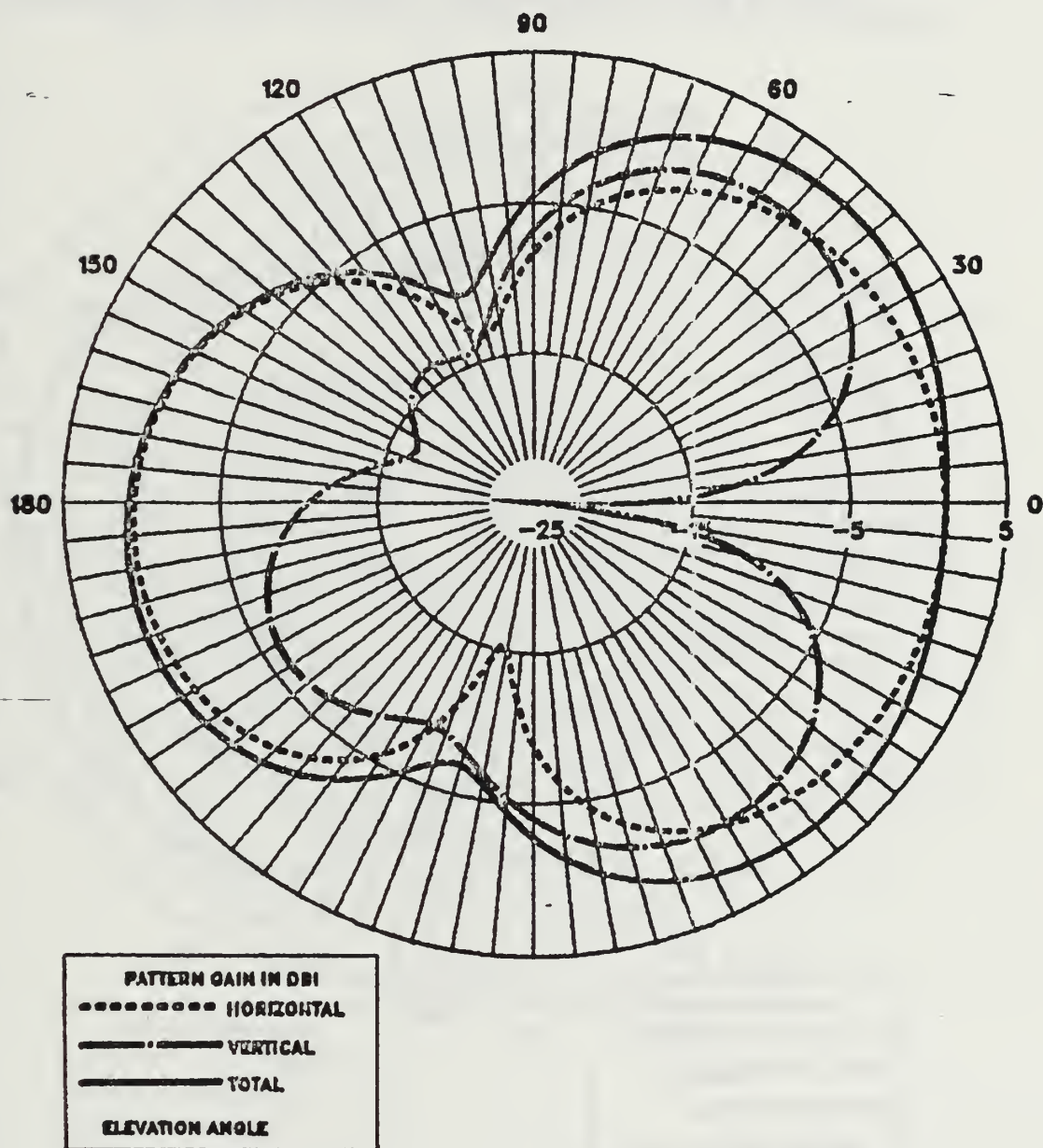
H60 IGUANA DATA RUN AT 18.1MHZ ON 8/22/87

CG 437R-2 ANT, FREE SPACE, VERT CUT, PHI=0



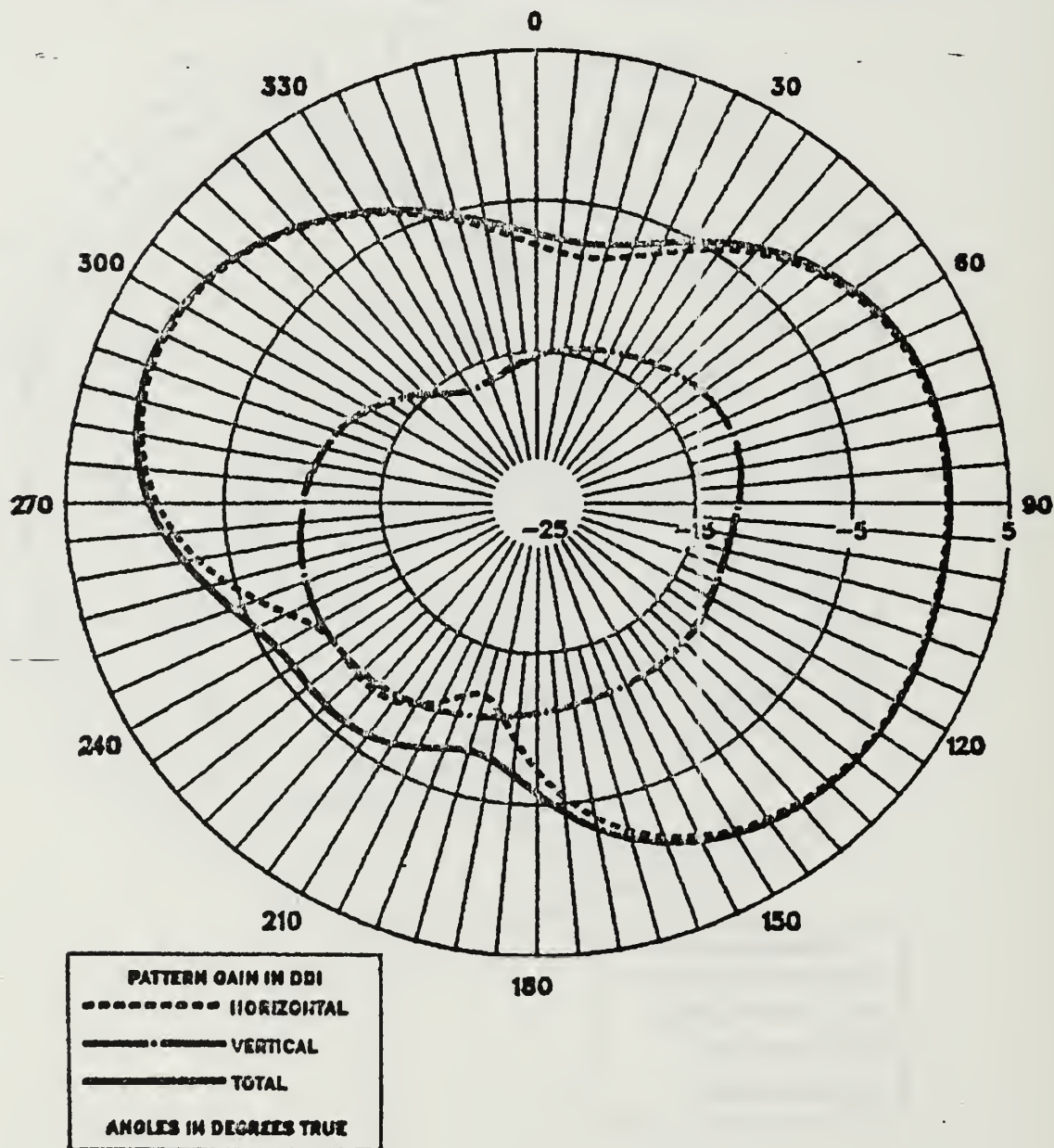
H60 IGUANA DATA RUN AT 18.1MHZ ON 8/22/87

CG 437R-2 ANT, FREE SPACE, VERT CUT, PHI=45



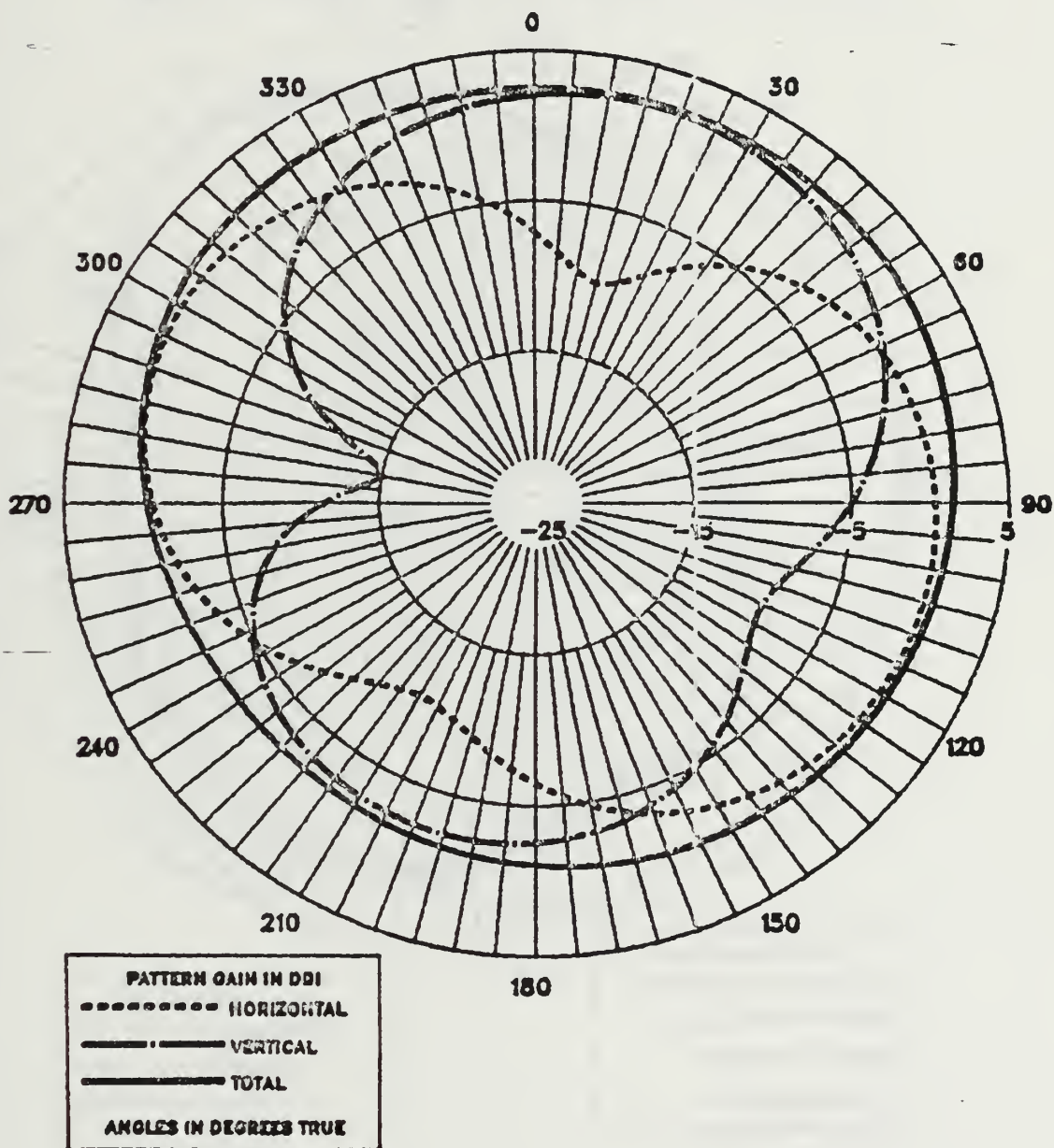
H60 IGUANA DATA RUN AT 18.1MHZ ON 8/22/87

ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CUT, THETA=90



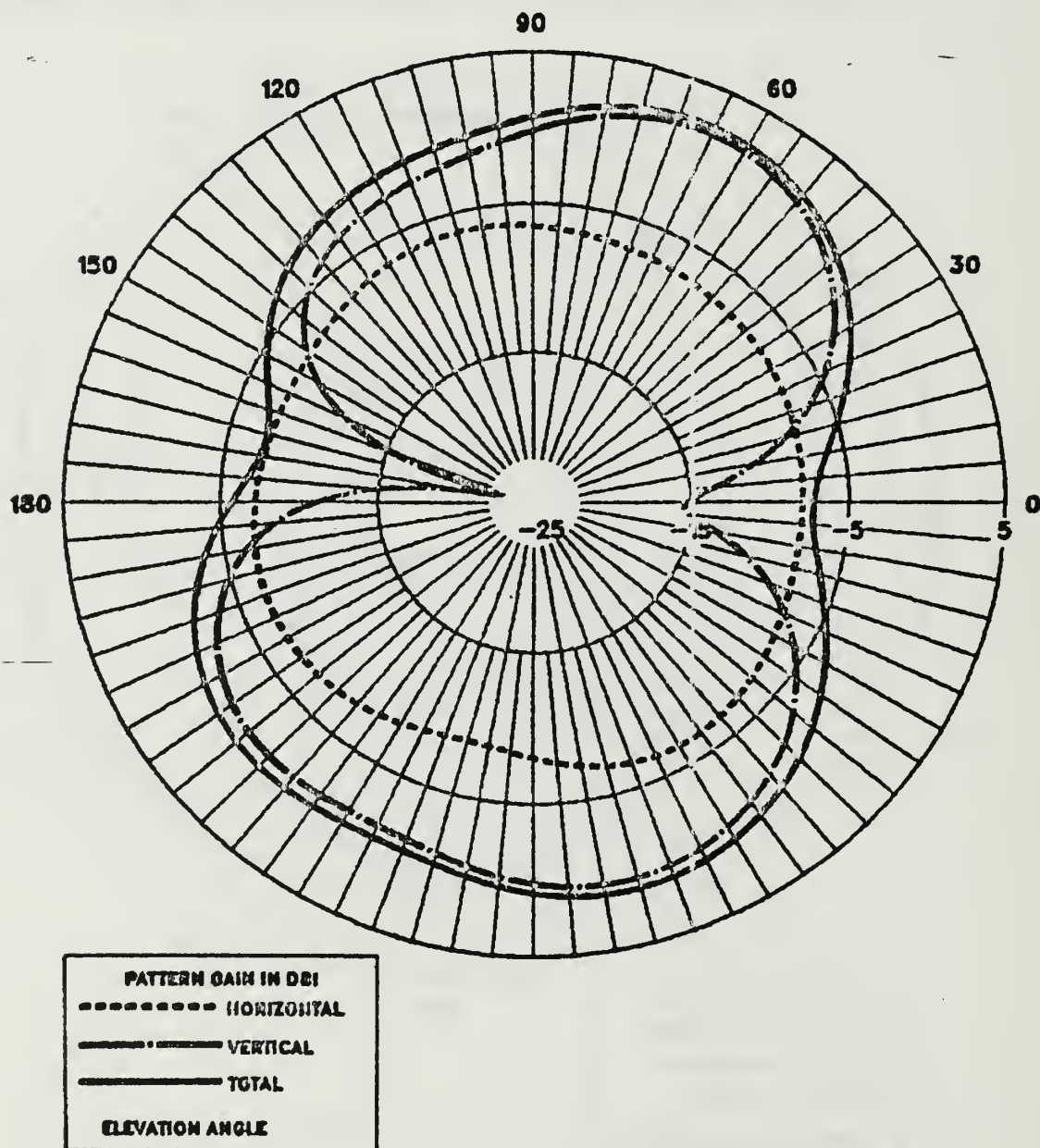
H60 IGUANA DATA RUN AT 18.1MHZ ON 8/22/87

ARMY-TYPE TUBE ANT, FREE SPACE, HORIZ CUT, THETA=26



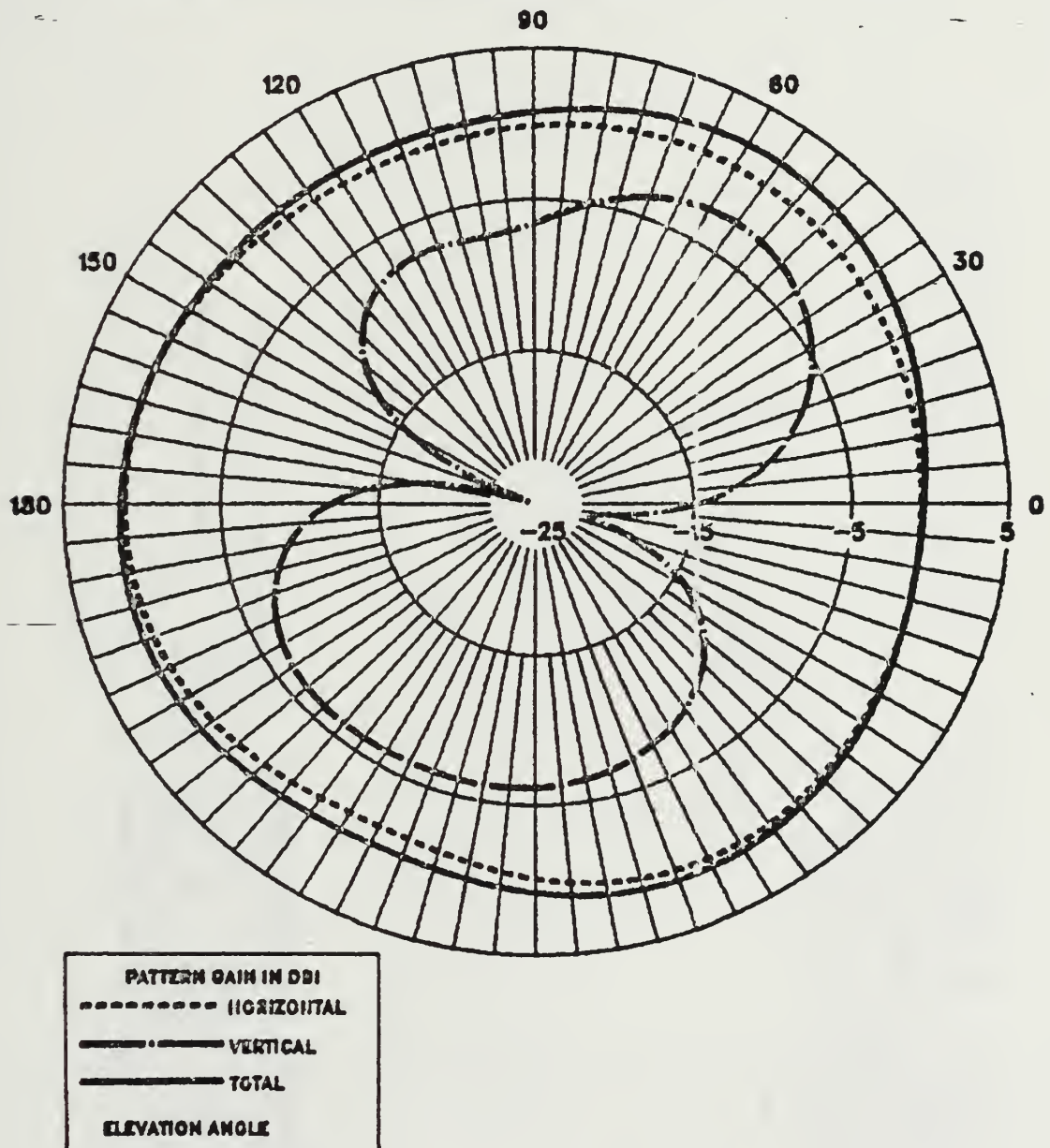
H60 IGUANA DATA RUN AT 18.1MHZ ON 8/22/87

ARMY-TYPE TUBE ANT, FREE SPACE, VERT CUT, $\Phi=0$



H60 IGUANA DATA RUN AT 18.1MHZ ON 8/22/87

ARMY-TYPE TUBE ANT, FREE SPACE, VERT CUT, PHI=45



APPENDIX B
ADVANCED PROPHET SCENARIO OUTPUT

ADVANCED
PROPHET
SYSTEM

NOSC 72



DEVELOPED AND MAINTAINED BY:
IONOSPHERIC BRANCH CODE 542 (ALGORITHM/MODEL DEVELOPMENT)
(619) 225-2002 / (AUTOVON) 933-2002
SIGNALS EXPLOITATION BRANCH CODE 772 (SYSTEM INTEGRATION)
(619) 225-2924 / (AUTOVON) 933-2924
NAVAL OCEAN SYSTEM CENTER
SAN DIEGO, CA. 92152-5000

$\frac{1}{2} \left(\frac{1}{2} \right) = \frac{1}{4}$

[illegible]

*** UNCLASSIFIED ***

ADVANCED PROPHET RAYTRACE SYNOPSIS

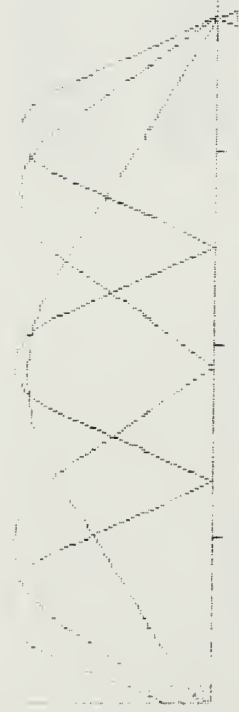
DATE: 1/ 1/86 TIME: 09:00 UT ATMOSPHERIC NOISE: YES BWIDTH: 2.800 KHZ
 FREQ: 3.1 SSN: 50.0 KP: 1.0 MAN-MADE NOISE: SH SNR REQD: 12.0 DB
 XMTR: HELO1 36- 0- 0 N 74-30- 0 W ANT: 0 @ *OMNI* PWR: 100.00
 RCVR: NFOLK 36-40-12 N 76-31-48 W ANT: 144 @ 1.5 RANGE: 106.0 NMI
 IONOSPHERE: FOF= .4 MHZ FOF1= .6 MHZ FOF2= 3.3
 HMF2= 350. KM YMF2=100.0 KM

NHOP	1	2	3	0	0	0
MODE	3000000	3300000	3330000	0000000	0000000	0000000
ANGLE	75.70	83.10	85.45	.00	.00	.00
DELAY(MSEC)	2.812	5.792	8.750	.000	.000	.000
LOSS(DB)	100.07	112.90	120.13	.00	.00	.00
GAIN TX/RX	0/-10	0/-10	0/-10	0/ 0	0/ 0	0/ 0
1HZ SNR(DB)	50.58	37.74	30.52	.00	.00	.00
ADJ SNR(DB)	16.11	3.27	-3.95	.00	.00	.00
VIR HT1(KM)	411.06	440.01	447.96	.00	.00	.00
VIR HT2(KM)	.00	427.13	437.91	.00	.00	.00
VIR HT3(KM)	.00	.00	429.47	.00	.00	.00

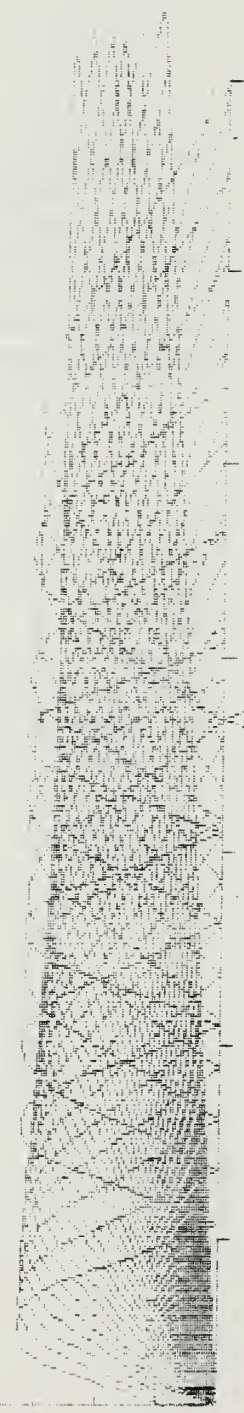
RA>

UNCLASSIFIED

001: 1/1/86 TIME: 09:00 UT ATMOSPHERIC NOISE: YES
 FREQ: 3.1 USN: 50.0 HP: 1.0 NON-NOISE NOISE: 50
 WAVE: HELD 36-0-0 N 72-30-0 H ANT: 0 0 0000000000
 GND: NEOLP 36-40-12 H 75-31-48 H ANT: 149 0 1.5 RANGE: 190.5 NM
 CA SPHERE: FOR: .4 MIZ FOR: .6 MIZ FOR: 3.3
 HME2: 350. MM YME2: 100.0 MM



PROPAGATING MODES MAX MODES ALLOWED: 3 EACH FIC: 100 MM



HAYFEN LAUNCH ANGLES: START 1.00 END: 07.00 INC: 2.00

*** UNCLASSIFIED ***

ADVANCED PROPHET RAYTRACE SYNOPSIS

DATE: 1/ 1/86 TIME: 09:00 UT ATMOSPHERIC NOISE: YES BWIDTH: 2.800 KHZ
 FREQ: 3.1 SSN: 50.0 KP: 1.0 MAN-MADE NOISE: SH SNR REQD: 12.0 DB
 XMTR: HELO2 36- 0- 0 N 72-30- 0 W ANT: 0 @ *OMNI* PWR: 100.00
 RCVR: NFOLK 36-40-12 N 76-31-48 W ANT: 144 @ 1.5 RANGE: 198.9 NMI
 IONOSPHERE: FOF= .4 MHZ FOF1= .6 MHZ FOF2= 3.3
 HMF2= 350. KM YMF2=100.0 KM

NHOP	1	2	3	0	0	0
MODE	3000000	3300000	3330000	0000000	0000000	0000000
ANGLE	61.85	76.95	81.55	.00	.00	.00
DELAY(MSEC)	2.750	5.787	8.904	.000	.000	.000
LOSS(DB)	99.38	111.88	119.60	.00	.00	.00
GAIN TX/RX	0/-10	0/-10	0/-10	0/ 0	0/ 0	0/ 0
1HZ SNR(DB)	51.27	38.77	31.04	.00	.00	.00
ADJ SNR(DB)	16.80	4.30	-3.43	.00	.00	.00
VIR HT1(KM)	367.20	436.29	463.46	.00	.00	.00
VIR HT2(KM)	.00	414.52	440.88	.00	.00	.00
VIR HT3(KM)	.00	.00	424.89	.00	.00	.00
RA>						

1. The first part of the document is a title page. It contains the title "THE HISTORY OF THE UNITED STATES OF AMERICA" and the author "BY JAMES M. SMITH".

2. The second part of the document is a table of contents. It lists the chapters and their corresponding page numbers.

3. The third part of the document is the first chapter, titled "THE DISCOVERY OF AMERICA". It describes the early exploration of the continent by Christopher Columbus and other European navigators.

4. The fourth part of the document is the second chapter, titled "THE SETTLEMENT OF AMERICA". It discusses the early colonial settlements and the challenges faced by the settlers.

5. The fifth part of the document is the third chapter, titled "THE REVOLUTIONARY WAR". It covers the events leading up to the war and the battle of independence.

6. The sixth part of the document is the fourth chapter, titled "THE CONSTITUTION". It explains the formation of the United States Constitution and its principles.

7. The seventh part of the document is the fifth chapter, titled "THE WESTERN EXPANSION". It describes the westward movement of the American population and the acquisition of new territories.

8. The eighth part of the document is the sixth chapter, titled "THE CIVIL WAR". It details the conflict between the Union and the Confederacy and its impact on the nation.

9. The ninth part of the document is the seventh chapter, titled "THE RECONSTRUCTION". It discusses the period following the Civil War and the efforts to rebuild the South.

10. The tenth part of the document is the eighth chapter, titled "THE MODERN UNITED STATES". It provides an overview of the current state of the nation and its future prospects.

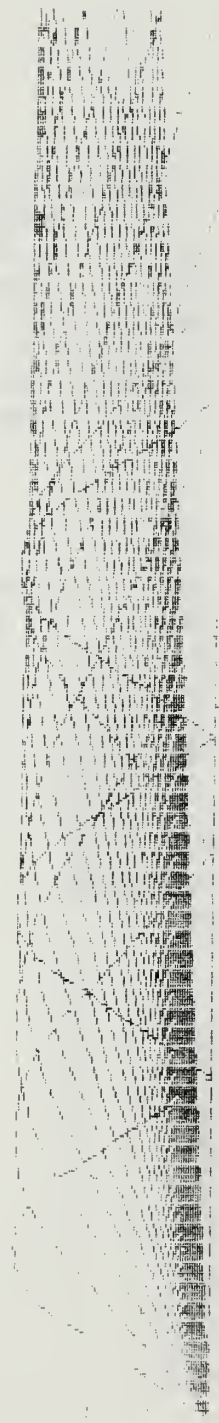
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DATE: 1/1/86 TIME: 09:00 UT ATMOSPHERIC NOISE: YES
PRF: 3.1 SSN: 50.0 RP: 1.0 MAN-AGE NOISE: SH
UTG: HELO4 36-0-0 N 75-0 W ANT: 9.0 *OMNI*
RCUR: NEOL4 36-40-12 N 75-31-48 W ANT: 182.0 *OMNI*
LOCUS: F0E- .4 MHZ FOF2 = .6 MHZ FOF3 = 3.
UNF2 = 350. MH VME2 = 100.0 RT

```



PROPAGATING MODES **HAX MODES ALLOWED:**

[illegible]

*** UNCLASSIFIED ***

ADVANCED PROPHET RAYTRACE SYNOPSIS

DATE: 1/ 1/86 TIME: 09:00 UT ATMOSPHERIC NOISE: YES BWIDTH: 2.800 KHZ
 FREQ: 3.1 SSN: 50.0 KP: 1.0 MAN-MADE NOISE: SH SNR REQD: 12.0 DB
 XMTR: HELO4 36- 0- 0 N 76- 0- 0 W ANT: 0 @ *OMNI* PWR: 100.00
 RCVR: NFOLK 36-40-12 N 76-31-48 W ANT: 182 @ *OMNI* RANGE: 47.7 NMI
 IONOSPHERE: FOF1= .4 MHZ FOF2= .6 MHZ FOF3= 3.3
 HMF2= 350. KM YMF2=100.0 KM

NHOP	1	2	0	0	0	0
MODE	3000000	3300000	0000000	0000000	0000000	0000000
ANGLE	83.70	86.85	.00	.00	.00	.00
DELAY(MSEC)	2.845	5.726	.000	.000	.000	.000
LOSS(DB)	100.83	112.98	.00	.00	.00	.00
GAIN TX/RX	0/-40	0/-40	0/ 0	0/ 0	0/ 0	0/ 0
1HZ SNR(DB)	19.57	7.42	.00	.00	.00	.00
ADJ SNR(DB)	-14.90	-27.06	.00	.00	.00	.00
VIR HT1(KM)	426.18	432.68	.00	.00	.00	.00
VIR HT2(KM)	.00	429.01	.00	.00	.00	.00
VIR HT3(KM)	.00	.00	.00	.00	.00	.00

RA>

*** UNCLASSIFIED *** DATE: 1/ 1 AT 09:00 UT
 GROUNDWAVE IS FROM HELO1 ON: 3.123 MHZ
 RANGE TO RECEIVER NFOLK IS: 106.0 NMI
 TRANSMIT GROUNDWAVE GAIN: .0 dBi
 POLARIZATION: V
 TRANSMIT ANTENNA HEIGHT: 500.0 FEET
 RECEIVE ANTENNA HEIGHT: .0 FEET
 TRANSMITTER POWER: 100.0 WATTS
 REQUIRED BANDWIDTH: 2.8 KHZ
 REQUIRED SIGNAL TO NOISE: 12.0 dB
 TERRAIN: SE
 SURFACE COVER: //
 SURFACE CONDUCTIVITY: .40E+01 MHO/M
 DIELECTRIC: 81.00
 WIND VELOCITY: 25.0 KNOTS
 MANMADE NOISE MODEL: SH
 ATMOSPHERIC NOISE: YES
 CALCULATED GROUNDWAVE LOSS: 83.49 dB
 REQUIRED POWER: 9.009 WATTS
 AVAILABLE POWER: 100.000 WATTS
 MAX RANGE FOR POWER OF 100.000 WATTS: 175.7 NMI
 NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi
 GW>

*** UNCLASSIFIED *** DATE: 1/ 1 AT 09:00 UT
 GROUNDWAVE IS FROM HELO2 ON: 3.123 MHZ
 RANGE TO RECEIVER NFOLK IS: 198.9 NMI
 TRANSMIT GROUNDWAVE GAIN: .0 dBi
 POLARIZATION: V
 TRANSMIT ANTENNA HEIGHT: 500.0 FEET
 RECEIVE ANTENNA HEIGHT: .0 FEET
 TRANSMITTER POWER: 100.0 WATTS
 REQUIRED BANDWIDTH: 2.8 KHZ
 REQUIRED SIGNAL TO NOISE: 12.0 dB
 TERRAIN: SE
 SURFACE COVER: //
 SURFACE CONDUCTIVITY: .40E+01 MHO/M
 DIELECTRIC: 81.00
 WIND VELOCITY: 25.0 KNOTS
 MANMADE NOISE MODEL: SH
 ATMOSPHERIC NOISE: YES
 CALCULATED GROUNDWAVE LOSS: 97.03 dB
 REQUIRED POWER: 202.093 WATTS
 AVAILABLE POWER: 100.000 WATTS
 ** SURFACE WAVE PROPAGATION TO RECEIVER NFOLK UNLIKELY **
 MAX RANGE FOR POWER OF 100.000 WATTS: 176.0 NMI
 NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi
 GW>

*** UNCLASSIFIED *** DATE: 1/ 1 AT 09:00 UT
 GROUNDWAVE IS FROM HELO3 ON: 3.123 MHZ
 RANGE TO RECEIVER NFOLK IS: 106.0 NMI
 TRANSMIT GROUNDWAVE GAIN: .0 dBi
 POLARIZATION: H
 TRANSMIT ANTENNA HEIGHT: 500.0 FEET
 RECEIVE ANTENNA HEIGHT: .0 FEET
 TRANSMITTER POWER: 100.0 WATTS
 REQUIRED BANDWIDTH: 2.8 KHZ
 REQUIRED SIGNAL TO NOISE: 12.0 dB
 TERRAIN: SE
 SURFACE COVER: //
 SURFACE CONDUCTIVITY: .40E+01 MHO/M
 DIELECTRIC: 81.00
 WIND VELOCITY: 25.0 KNOTS
 MANMADE NOISE MODEL: SH
 ATMOSPHERIC NOISE: YES
 CALCULATED GROUNDWAVE LOSS: 192.16 dB
 REQUIRED POWER: 100.000 WATTS
 AVAILABLE POWER: 100.000 WATTS

** SURFACE WAVE PROPAGATION TO RECEIVER NFOLK UNLIKELY **
 SIGNIFICANT IMPROVEMENT MAY BE GAINED WITH VERTICAL POLARIZATION.
 MAX RANGE FOR POWER OF 100.000 WATTS: 10.8 NMI
 NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi

GW)

SELECT DISPLAY OPTION (A/F/P/E)

GW>a

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DATE: 1/ 1 AT 09:00 UT

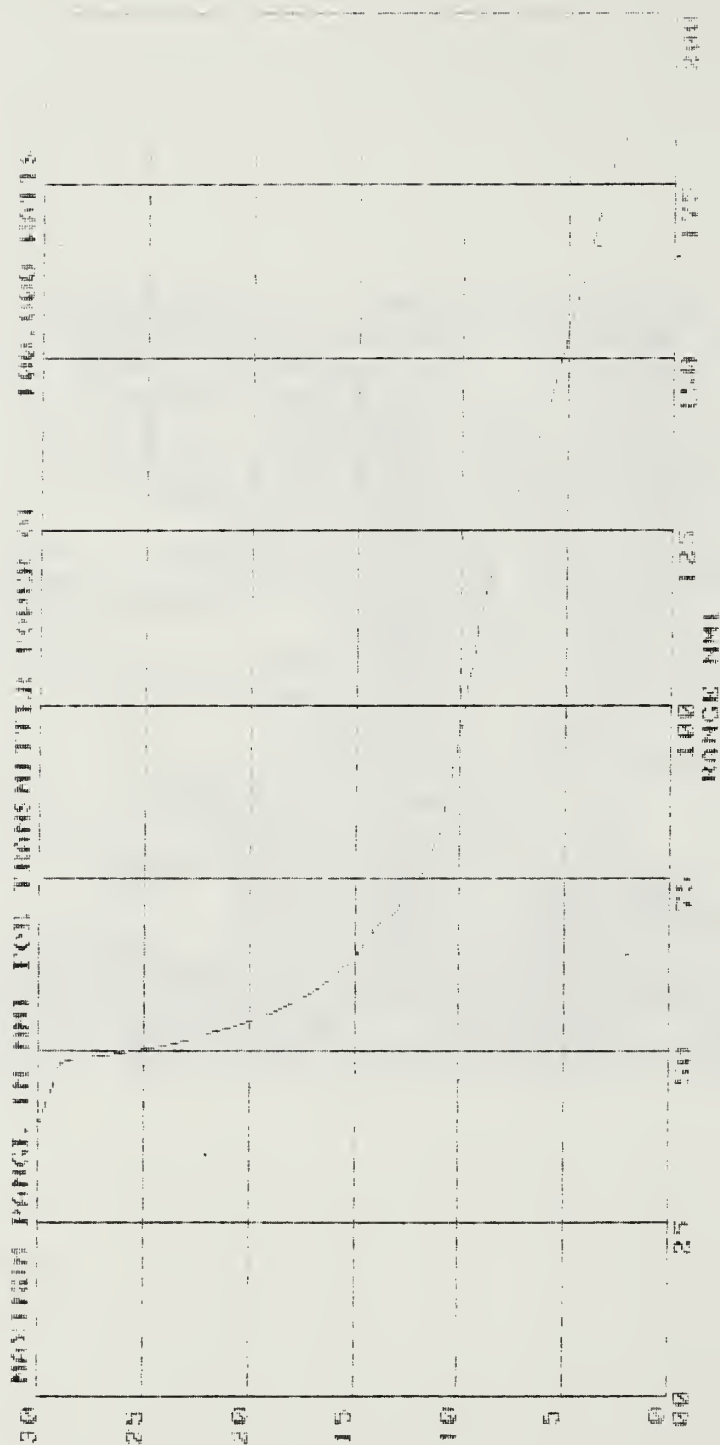
GROUNDWAVE IS FROM HELO4 ON:	3.123 MHZ
RANGE TO RECEIVER NFOLK IS:	47.7 NMI
TRANSMIT GROUNDWAVE GAIN:	.0 dBi
POLARIZATION:	V
TRANSMIT ANTENNA HEIGHT:	500.0 FEET
RECEIVE ANTENNA HEIGHT:	.0 FEET
TRANSMITTER POWER:	100.0 WATTS
REQUIRED BANDWIDTH:	2.8 KHZ
REQUIRED SIGNAL TO NOISE:	12.0 dB
TERRAIN:	SE
SURFACE COVER:	//
SURFACE CONDUCTIVITY:	.40E+01 MHO/M
DIELECTRIC:	81.00
WIND VELOCITY:	25.0 KNOTS
MANMADE NOISE MODEL:	SH
ATMOSPHERIC NOISE:	YES
CALCULATED GROUNDWAVE LOSS:	72.76 dB
REQUIRED POWER:	.766 WATTS
AVAILABLE POWER:	100.000 WATTS

MAX RANGE FOR POWER OF 100.000 WATTS: 175.5 NMI

NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi
GW>

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GROUNDWAVE ANALYSIS FOR DATE: 1/1/86 TIME: 07:00 H
 STATION: HELIX POLARIZATION: V POWER: 100.000 WATTS
 FREQUENCY: 3.123 MHZ RANGE: 17.7 NM
 ANTENNA HEIGHT: 500.0 FEET ROOF: 1.8 FEET
 WIND: 25 KNOTS ATMOSPHERIC NOISE: VPS
 SURFACE CONDUCTIVITY: 0.0001 MUOM
 BANDWIDTH: 12.6 KB BANDWIDTH: 2.000 KHZ MANMADE NOISE: 50



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 AREA COVERAGE I DATE: 1/1/06 TIME: 00:00 UT

TRANSMITTER FREQUENCY: 5.70 MHz



35.0 30.0 25.0 20.0 15.0 10.0 5.0 0.0 -5.0 -10.0 -15.0 -20.0 -25.0 -30.0 -35.0 -40.0

LOW: 45.0

55.0

AREA COVERAGE I X

UNCLASSIFIED

UNCLASSIFIED

The figure consists of 17 numbered steps (1-17) illustrating the assembly of a complex geometric form. The process begins with individual rectangular components (steps 1-4) and progresses through various intermediate shapes formed by combining these blocks (steps 5-10). The final stages (steps 11-17) show the completed structure with additional decorative elements like dots and lines being added to specific parts.

[illegible]

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for transparency and accountability, particularly in financial matters.

2. The second part outlines the various methods and tools used to collect and analyze data. This includes the use of surveys, interviews, and statistical software to ensure that the information gathered is reliable and valid.

3. The third part focuses on the ethical considerations surrounding data collection and analysis. It highlights the need to protect individual privacy and ensure that data is used responsibly and for its intended purpose.

4. The fourth part discusses the challenges faced in the process of data collection and analysis. These challenges include issues related to data quality, sample bias, and the complexity of interpreting results.

5. The fifth part provides a summary of the findings and conclusions drawn from the study. It reiterates the importance of rigorous methodology and ethical standards in conducting research.

6. The final part of the document offers recommendations for future research and practice. It suggests areas for further exploration and provides guidance on how to apply the findings to real-world situations.

1. The first part of the document is a list of references. The references are listed in a standard format, with the author's name, the title of the work, and the publisher. The references are as follows:

1. J. H. Van Veen, *The History of the Netherlands*, 1910, 1911, 1912, 1913, 1914, 1915, 1916, 1917, 1918, 1919, 1920, 1921, 1922, 1923, 1924, 1925, 1926, 1927, 1928, 1929, 1930, 1931, 1932, 1933, 1934, 1935, 1936, 1937, 1938, 1939, 1940, 1941, 1942, 1943, 1944, 1945, 1946, 1947, 1948, 1949, 1950, 1951, 1952, 1953, 1954, 1955, 1956, 1957, 1958, 1959, 1960, 1961, 1962, 1963, 1964, 1965, 1966, 1967, 1968, 1969, 1970, 1971, 1972, 1973, 1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578,

*** UNCLASSIFIED ***

DATE: 1/1/06 TIME: 09:00 UT ATMOSPHERIC NOISE: YES
CPR: 5.7 SSN: 50.0 KP: 1.0 MAN-MADE NOISE: NO
SHT: HELIX 36-0-0 N 76-0-0 W AMT: 0.0 COMNIT* PRR: 100.00
Q UR: NEOLK 35-40 12 N 76-31-48 W AMT: 182.0 COMNIT* RANGE: 47.7 NM
IONOSPHERE: FOF2= .4 Mhz FOF1= .6 Mhz FOF2= 3.3
HMF2= 350. KM YMF2=100.0 KM

PROPAGATING MODES MAX MODES ALLOWED= 3 EACH TIC= 100 KM

RAYAN LAUNCH ANGLES: START= 1.00 END= 87.00 INC= 2.00

*** UNCLASSIFIED *** DATE: 1/ 1 AT 09:00 UT
 GROUNDWAVE IS FROM HELO1 ON: 5.696 MHZ
 RANGE TO RECETIVER NFOLK IS: 106.0 NMI
 TRANSMIT GROUNDWAVE GAIN: .0 dBi
 POLARIZATION: V
 TRANSMIT ANTENNA HEIGHT: 500.0 FEET
 RECEIVE ANTENNA HEIGHT: .0 FEET
 TRANSMITTER POWER: 100.0 WATTS
 REQUIRED BANDWIDTH: 2.8 KHZ
 REQUIRED SIGNAL TO NOISE: 12.0 dB
 TERRAIN: SE
 SURFACE COVER: //
 SURFACE CONDUCTIVITY: .40E+01 MHO/M
 DIELECTRIC: 81.00
 WIND VELOCITY: 25.0 KNOTS
 MANMADE NOISE MODEL: SH
 ATMOSPHERIC NOISE: YES
 CALCULATED GROUNDWAVE LOSS: 93.53 dB
 REQUIRED POWER: 17.655 WATTS
 AVAILABLE POWER: 100.000 WATTS
 MAX RANGE FOR POWER OF 100.000 WATTS: 145.5 NMI
 NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi
 GW>

*** UNCLASSIFIED *** DATE: 1/ 1 AT 09:00 UT
 GROUNDWAVE IS FROM HELO2 ON: 5.696 MHZ
 RANGE TO RECEIVER NFOLK IS: 198.9 NMI
 TRANSMIT GROUNDWAVE GAIN: .0 dBi
 POLARIZATION: V
 TRANSMIT ANTENNA HEIGHT: 500.0 FEET
 RECEIVE ANTENNA HEIGHT: .0 FEET
 TRANSMITTER POWER: 100.0 WATTS
 REQUIRED BANDWIDTH: 2.8 KHZ
 REQUIRED SIGNAL TO NOISE: 12.0 dB
 TERRAIN: SE
 SURFACE COVER: //
 SURFACE CONDUCTIVITY: .40E+01 MHO/M
 DIELECTRIC: 81.00
 WIND VELOCITY: 25.0 KNOTS
 MANMADE NOISE MODEL: SH
 ATMOSPHERIC NOISE: YES
 CALCULATED GROUNDWAVE LOSS: 110.23 dB
 REQUIRED POWER: 821.762 WATTS
 AVAILABLE POWER: 100.000 WATTS
 ** SURFACE WAVE PROPAGATION TO RECEIVER NFOLK UNLIKELY **
 MAX RANGE FOR POWER OF 100.000 WATTS: 145.7 NMI
 NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi
 GW>

SELECT DISPLAY OPTION (A/F/P/E)

GW>a

*** UNCLASSIFIED *** DATE: 1/ 1 AT 09:00 UT
GROUNDWAVE IS FROM HELO4 ON: 5.696 MHZ
RANGE TO RECEIVER NFOLK IS: 47.7 NMI
TRANSMIT GROUNDWAVE GAIN: .0 dBi
POLARIZATION: V
TRANSMIT ANTENNA HEIGHT: 500.0 FEET
RECEIVE ANTENNA HEIGHT: .0 FEET
TRANSMITTER POWER: 100.0 WATTS
REQUIRED BANDWIDTH: 2.8 KHZ
REQUIRED SIGNAL TO NOISE: 12.0 dB
TERRAIN: SE
SURFACE COVER: //
SURFACE CONDUCTIVITY: .40E+01 MHO/M
DIELECTRIC: 81.00
WIND VELOCITY: 25.0 KNOTS
MANMADE NOISE MODEL: SH
ATMOSPHERIC NOISE: YES
CALCULATED GROUNDWAVE LOSS: 79.52 dB
REQUIRED POWER: .704 WATTS
AVAILABLE POWER: 100.000 WATTS
MAX RANGE FOR POWER OF 100.000 WATTS: 145.4 NMI
NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi
GW>

*** UNCLASSIFIED ***

AREA COVERAGE I DOIR: 1/1/86 TIME: 10:00 M

TRANSMITTER FREQUENCY: 3.12 MHZ



HFLO4 (X) COVERAGE : X

1.00

UNCLASSIFIED ***

DATE: 1/1/05 TIME: 18:00 UT ATMOSPHERIC NOISE: YES
REQ: 3.1 SSN: 50.0 RP: 1.0 MAN-MADE NOISE: SH SWR RECD: 13.0 DB
CHIR: HELD 36 0-0 N 76-0 0 M ANT: 0 0 MONITOR PWR: 100.00
C9R: NTCOR 36-40-12 N 76-31-40 M ANT: 182 0 MONITOR RANGE: 47.7 NM
ONOSPHERE: FOF2: 3.0 MHZ FOF1: 4.2 MHZ FOF2: 8.6
MUF2: 34.1 KM ZMF2: 119.6 KM

RECEIVED

PROPAGATING MODES MAX MODES ALLOWED: 3 EQUATION: 100 KM

ROYFAM LAUNCH DATES: START 1.00 END: 8.00 TIME: 1.00

*** UNCLASSIFIED ***

ADVANCED PROPHET RAYTRACE SYNOPSIS

DATE: 1/ 1/86 TIME: 18:00 UT ATMOSPHERIC NOISE: YES BWIDTH: 2.800 KHZ
 FREQ: 3.1 SSN: 50.0 KP: 1.0 MAN-MADE NOISE: SH SNR REQD: 12.0 DB
 XMTR: HELO4 36- 0- 0 N 76- 0- 0 W ANT: 0 @ *OMNI* PWR: 100.00
 RCVR: NFOLK 36-40-12 N 76-31-48 W ANT: 182 @ *OMNI* RANGE: 47.7 NMI
 IONOSPHERE: FOF1= 3.0 MHZ FOF2= 4.2 MHZ FOF3= 8.6
 HMF2= 341. KM YMF2=119.6 KM

NHOP	1	2	4	0	0	0
MODE	1000000	2200000	2222000	0000000	0000000	0000000
ANGLE	69.50	82.85	86.40	.00	.00	.00
DELAY(MSEC)	.856	2.436	4.816	.000	.000	.000
LOSS(DB)	133.60	189.60	271.87	.00	.00	.00
GAIN TX/RX	0/-18	0/-40	0/-40	0/ 0	0/ 0	0/ 0
1HZ SNR(DB)	9.30	-68.70	EXCESSIVE	.00	.00	.00
ADJ SNR(DB)	-25.17	-103.17	EXCESSIVE	.00	.00	.00
VIR HT1(KM)	120.40	182.03	180.95	.00	.00	.00
VIR HT2(KM)	.00	181.47	180.74	.00	.00	.00
VIR HT3(KM)	.00	.00	180.55	.00	.00	.00

RA>

SELECT DISPLAY OPTION (A/F/P/E)

GW>a

*** UNCLASSIFIED *** DATE: 1/ 1 AT 18:00 UT

GROUNDWAVE IS FROM HELO4	ON:	3.123 MHZ
RANGE TO RECEIVER NFOLK	IS:	47.7 NMI
TRANSMIT GROUNDWAVE GAIN:		.0 dBi
POLARIZATION:		V
TRANSMIT ANTENNA HEIGHT:		500.0 FEET
RECEIVE ANTENNA HEIGHT:		.0 FEET
TRANSMITTER POWER:		100.0 WATTS
REQUIRED BANDWIDTH:		2.8 KHZ
REQUIRED SIGNAL TO NOISE:		12.0 dB
TERRAIN:		SE
SURFACE COVER:		//
SURFACE CONDUCTIVITY:		.40E+01 MHO/M
DIELECTRIC:		81.00
WIND VELOCITY:		25.0 KNOTS
MANMADE NOISE MODEL:		SH
ATMOSPHERIC NOISE:		YES
CALCULATED GROUNDWAVE LOSS:		72.76 dB
REQUIRED POWER:		.681 WATTS
AVAILABLE POWER:		100.000 WATTS

MAX RANGE FOR POWER OF 100.000 WATTS: 179.3 NMI

NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi

GW>

[illegible]

Figure 1. Schematic representation of the experimental design. The first part of the study was a pretest in which the effect of the number of items on the recognition of the faces was tested. The second part of the study was a main experiment in which the effect of the number of items on the recognition of the faces was tested. The third part of the study was a posttest in which the effect of the number of items on the recognition of the faces was tested.



1. *Chlorophyll a* (Chl a) content was determined using a spectrophotometer (Shimadzu UV-160U) at 663 nm. The concentration of Chl a was calculated using the following formula: $\text{Chl a (mg/L)} = 12.7 \times \text{OD}_{663}$.

$$\frac{d}{dt} \left(\frac{\partial L}{\partial \dot{x}} \right) = \frac{\partial L}{\partial x}$$

100

[illegible]

1. The first step is to identify the problem or question that needs to be answered. This involves understanding the context and the specific requirements of the task.

[illegible]

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ADVANCED PROPHET RAYTRACE SYNOPSIS

DATE: 1/ 1/86 TIME: 18:00 UT ATMOSPHERIC NOISE: YES BWIDTH: 2.800 KHZ
 FREQ: 5.7 SSN: 50.0 KP: 1.0 MAN-MADE NOISE: SH SNR REQD: 12.0 DB
 XMTR: HELO1 36- 0- 0 N 74-30- 0 W ANT: 0 @ *OMNI* PWR: 100.00
 RCVR: NFOLK 36-40-12 N 76-31-48 W ANT: 144 @ 1.5 RANGE: 106.0 NMI
 IONOSPHERE: FOF= 3.0 MHZ FOF1= 4.2 MHZ FOF2= 8.6
 HMF2= 341. KM YMF2=119.5 KM

NHOP	1	2	3	0	0	0
MODE	3000000	3300000	3330000	0000000	0000000	0000000
ANGLE	72.40	80.95	83.95	.00	.00	.00
DELAY(MSEC)	2.262	4.368	6.511	.000	.000	.000
LOSS(DB)	121.19	147.74	170.09	.00	.00	.00
GAIN TX/RX	0/-11	0/-13	0/-13	0/ 0	0/ 0	0/ 0
1HZ SNR(DB)	36.18	7.64	-14.72	.00	.00	.00
ADJ SNR(DB)	1.71	-26.83	-49.19	.00	.00	.00
VIR HT1(KM)	326.01	325.04	324.96	.00	.00	.00
VIR HT2(KM)	.00	325.75	325.43	.00	.00	.00
VIR HT3(KM)	.00	.00	325.91	.00	.00	.00
RA>						

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ADVANCED PROPHET RAYTRACE SYNOPSIS

DATE: 1/ 1/86 TIME: 18:00 UT ATMOSPHERIC NOISE: YES BWIDTH: 2.800 KHZ
 FREQ: 5.7 SSN: 50.0 KP: 1.0 MAN-MADE NOISE: SH SNR REQD: 12.0 DB
 XMTR: HELO2 36- 0- 0 N 72-30- 0 W ANT: 0 @ *OMNI* PWR: 100.00
 RCVR: NFOLK 36-40-12 N 76-31-48 W ANT: 144 @ 1.5 RANGE: 198.9 NMI
 IONOSPHERE: FOF1= 3.0 MHZ FOF1= 4.2 MHZ FOF2= 8.6
 HMF2= 342. KM YMF2=119.5 KM

NHOP	1	2	3	0	0	0
MODE	3000000	3300000	3330000	0000000	0000000	0000000
ANGLE	59.85	73.45	78.80	.00	.00	.00
DELAY (MSEC)	2.556	4.505	6.605	.000	.000	.000
LOSS (DB)	125.32	148.93	170.71	.00	.00	.00
GAIN TX/RX	0/ -8	0/-11	0/-11	0/ 0	0/ 0	0/ 0
1HZ SNR (DB)	35.06	8.44	-13.34	.00	.00	.00
ADJ SNR (DB)	.59	-26.03	-47.81	.00	.00	.00
VIR HT1 (KM)	336.82	326.25	325.87	.00	.00	.00
VIR HT2 (KM)	.00	326.41	325.96	.00	.00	.00
VIR HT3 (KM)	.00	.00	326.06	.00	.00	.00

RA>

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DATE: 1/1/86 TIME: 18:00 UT ATMOSPHERIC NOISE: YES
FREQ: 5.7 SSN: 00.0 RP: 1.0, MAN-MADE NOISE: NO
WIND: BELO 36-0 0 M 76-0-0 0 OUT: 0 0 COMM IN PAR: 108.00
RDR: WFOLK 36-10-12 M 76-31-48 M OUT: 102 0 COMM IN RANGE: 47.7 NM
IONOSPHERE: FOF1 3.0 MHZ FOF2 4.2 MHZ FOF3 8.6
HMF2 311. KM YNF2 119.6 KM

PROPAGATING MODES MAX MODES ALLOWED 3 EACH TIC: 100 KM

RAYFAN LAUNCH ANGLES: START 1.00 DEG BY 0.5 INC: 2.00

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ADVANCED PROPHET RAYTRACE SYNOPSIS

DATE: 1/ 1/86 TIME: 18:00 UT ATMOSPHERIC NOISE: YES BWIDTH: 2.800 KHZ
 FREQ: 5.7 SSN: 50.0 KP: 1.0 MAN-MADE NOISE: SH SNR REQD: 12.0 DB
 XMTR: HELO4 36- 0- 0 N 76- 0- 0 W ANT: 0 @ *OMNI* PWR: 100.00
 RCVR: NFOLK 36-40-12 N 76-31-48 W ANT: 182 @ *OMNI* RANGE: 47.7 NMI
 IONOSPHERE: FOF1= 3.0 MHZ FOF2= 4.2 MHZ FOF3= 8.6
 HMF2= 341. KM YMF2=119.6 KM

NHOP	1	2	0	0	0	0
MODE	3000000	3300000	0000000	0000000	0000000	0000000
ANGLE	81.85	85.90	.00	.00	.00	.00
DELAY(MSEC)	2.177	4.323	.000	.000	.000	.000
LOSS(DB)	119.85	147.35	.00	.00	.00	.00
GAIN TX/RX	0/-40	0/-40	0/ 0	0/ 0	0/ 0	0/ 0
1HZ SNR(DB)	8.28	-19.23	.00	.00	.00	.00
ADJ SNR(DB)	-26.19	-53.70	.00	.00	.00	.00
VIR HT1(KM)	325.02	324.51	.00	.00	.00	.00
VIR HT2(KM)	.00	325.63	.00	.00	.00	.00
VIR HT3(KM)	.00	.00	.00	.00	.00	.00
RA>						

*** UNCLASSIFIED *** DATE: 1/ 1 AT 18:00 UT
 GROUNDWAVE IS FROM HELO1 ON: 5.696 MHZ
 RANGE TO RECEIVER NFOLK IS: 106.0 NMI
 TRANSMIT GROUNDWAVE GAIN: .0 dBi
 POLARIZATION: V
 TRANSMIT ANTENNA HEIGHT: 500.0 FEET
 RECEIVE ANTENNA HEIGHT: .0 FEET
 TRANSMITTER POWER: 100.0 WATTS
 REQUIRED BANDWIDTH: 2.8 KHZ
 REQUIRED SIGNAL TO NOISE: 12.0 dB
 TERRAIN: SE
 SURFACE COVER: //
 SURFACE CONDUCTIVITY: .40E+01 MHO/M
 DIELECTRIC: 81.00
 WIND VELOCITY: 25.0 KNOTS
 MANMADE NOISE MODEL: SH
 ATMOSPHERIC NOISE: YES
 CALCULATED GROUNDWAVE LOSS: 93.53 dB
 REQUIRED POWER: 15.392 WATTS
 AVAILABLE POWER: 100.000 WATTS
 MAX RANGE FOR POWER OF 100.000 WATTS: 148.8 NMI
 NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi
 GW>

*** UNCLASSIFIED *** DATE: 1/ 1 AT 18:00 UT
 GROUNDWAVE IS FROM HELO2 ON: 5.696 MHZ
 RANGE TO RECEIVER NFOLK IS: 198.9 NMI
 TRANSMIT GROUNDWAVE GAIN: .0 dBi
 POLARIZATION: V
 TRANSMIT ANTENNA HEIGHT: 500.0 FEET
 RECEIVE ANTENNA HEIGHT: .0 FEET
 TRANSMITTER POWER: 100.0 WATTS
 REQUIRED BANDWIDTH: 2.8 KHZ
 REQUIRED SIGNAL TO NOISE: 12.0 dB
 TERRAIN: SE
 SURFACE COVER: //
 SURFACE CONDUCTIVITY: .40E+01 MHO/M
 DIELECTRIC: 81.00
 WIND VELOCITY: 25.0 KNOTS
 MANMADE NOISE MODEL: SH
 ATMOSPHERIC NOISE: YES
 CALCULATED GROUNDWAVE LOSS: 110.23 dB
 REQUIRED POWER: 721.029 WATTS
 AVAILABLE POWER: 100.000 WATTS

** SURFACE WAVE PROPAGATION TO RECEIVER NFOLK UNLIKELY **
 MAX RANGE FOR POWER OF 100.000 WATTS: 148.8 NMI
 NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi
 GW>

SELECT DISPLAY OPTION (A/F/P/E)

GW>a

*** UNCLASSIFIED *** DATE: 1/ 1 AT 18:00 UT

GROUNDWAVE IS FROM HELO4 ON: 5.696 MHZ

RANGE TO RECEIVER NFOLK IS: 47.7 NMI

TRANSMIT GROUNDWAVE GAIN: .0 dBi

POLARIZATION: V

TRANSMIT ANTENNA HEIGHT: 500.0 FEET

RECEIVE ANTENNA HEIGHT: .0 FEET

TRANSMITTER POWER: 100.0 WATTS

REQUIRED BANDWIDTH: 2.8 KHZ

REQUIRED SIGNAL TO NOISE: 12.0 dB

TERRAIN: SE

SURFACE COVER: //

SURFACE CONDUCTIVITY: .40E+01 MHO/M

DIELECTRIC: 81.00

WIND VELOCITY: 25.0 KNOTS

MANMADE NOISE MODEL: SH

ATMOSPHERIC NOISE: YES

CALCULATED GROUNDWAVE LOSS: 79.52 dB

REQUIRED POWER: .611 WATTS

AVAILABLE POWER: 100.000 WATTS

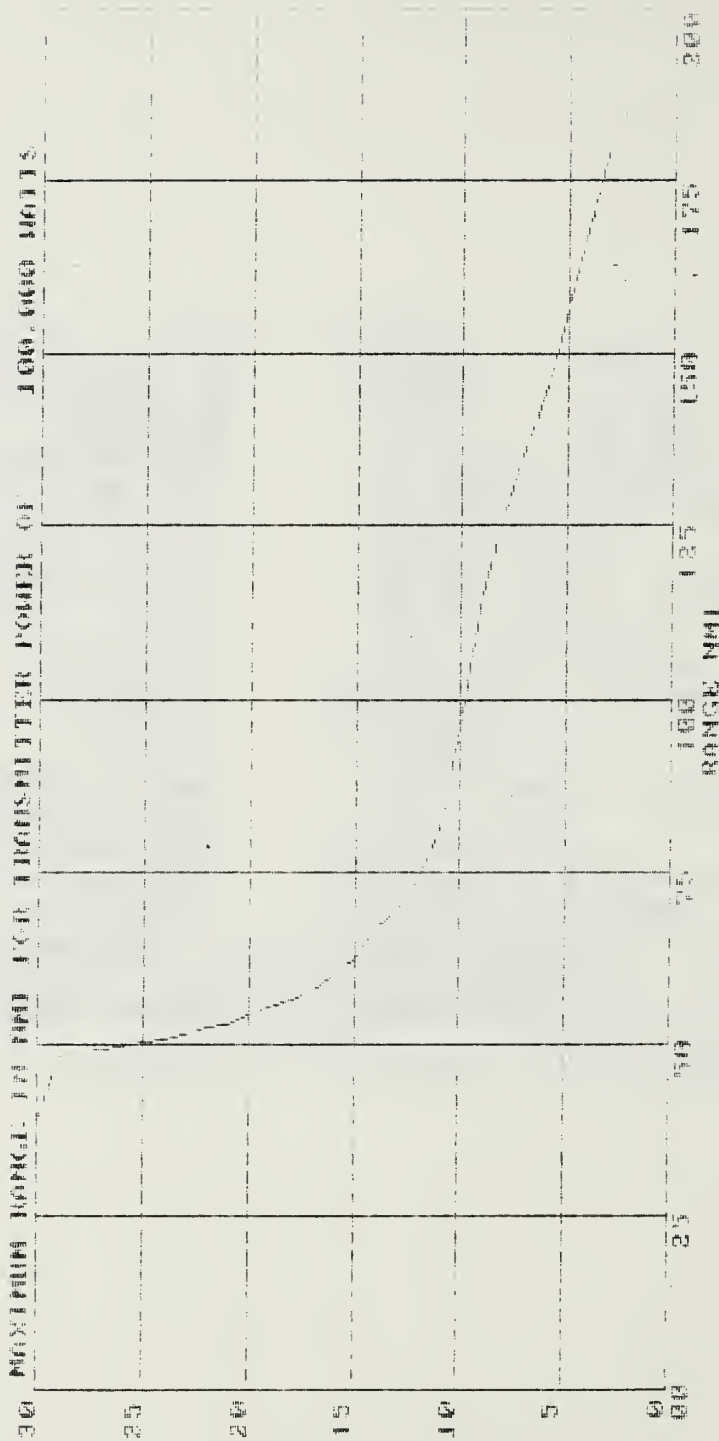
MAX RANGE FOR POWER OF 100.000 WATTS: 148.8 NMI

NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi

GW>

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GROUNDWATER ANALYSIS FOR DATE: 11/1/86 TIME: 10:00 HT
 XMITR: HELIX POLARIZATION: 0 POWER: 100.000 WATTS
 RXTR: HELIX FREQUENCY: 5.696 MHZ RANGE: 47.7 NMI
 ANTENNA HEIGHT XMITR: 500.0 FEET RXTR: .0 FEET
 TERRAIN: SE COVER: // WIND: 25.0 KNOTS ATMOSPHERIC NOISE: YES
 DIELECTRIC: 81.0 SURFACE CONDUCTIVITY: .40E+01 MHQ/M
 SPEED SHR: 12.0 DB BANDWIDTH: 2.800 KHZ MONITOR NOISE: 50



5 2 6 9 11 13 15 17 19 21 23 25

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AREA COVERAGE I DATE: 1/1/86 TIME: 18:49 H

TRANSMITTER FREQUENCY: 8.98 MHZ



86.0 LON: WEST 66.0

AREA COVERAGE = X

UNCLASSIFIED

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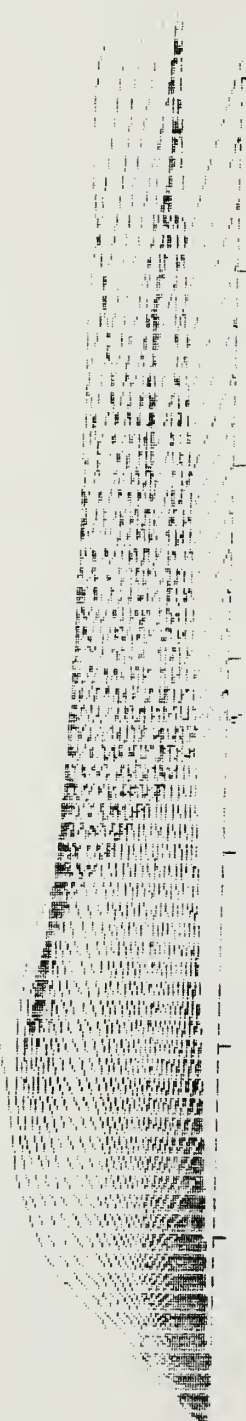
[illegible][illegible][illegible]

*** UNCLASSIFIED ***

DATE: 1/1/86 TIME: 18:00 J1 ATMOSPHERIC NOISE: YES
 CREQ: 9.0 SSN: 50.0 RP: 1.0 MOD MODE NOISE: SH
 CMTR: HELQ2 36-0-0 M 72-30 0 M ONI: 9.0 COMH1* OUR: 12.0 DB
 QTR: WFOK 36-40-12 N 76 31-48 W ONI: 102.0 COMH1* RANGE: 100.00
 IONOSPHERE: FOF2= 1.0 MHz FOF1= 1.2 MHz FOF3= 8.6
 HMF2= 341. KM VME2=119.3 KM

PROPAGATING MODES

MAX MODES ALLOWED= 3 EACH 113= 100 KM



RAYFON

LAUNCH ANGLES: START= 1.00 END= 87.00 INC= 2.00

UNCLASSIFIED XXX

DATE: 1/1/85 TIME: 18:00 UT ATMOSPHERIC NOISE: YES
 PRF: 9.0 SSN: 50.0 RP: 1.0 | MIN MODE NOISE: SH SNR REQ: 12.0 dB
 XPR: HELIX 36-0-0 N 76-0-0 H 6M: 0.0 COM1: PWR: 100.00
 RPR: NEOLX 36-40-12 N 76-31-48 H 0M: 132.0 COM1: RANGE: 47.7 HAT
 IONOSPHERE: FOF2: 3.0 MHz FOF1: 4.2 MHz FOF2: H.G
 HRF2: 340. KH FNF2: 119.5 KM

PROPAGATING MODES MAX MODES ALLOWED: 3 EARTH IIC: 100 KM

BOYFON LAUNCH ANGLES: START: 1.00 END: 87.00 IIC: 2.00

*** UNCLASSIFIED *** DATE: 1/ 1 AT 18:00 UT
 GROUNDWAVE IS FROM HELO1 ON: 8.984 MHZ
 RANGE TO RECEIVER NFOLK IS: 106.0 NMI
 TRANSMIT GROUNDWAVE GAIN: .0 dBi
 POLARIZATION: V
 TRANSMIT ANTENNA HEIGHT: 500.0 FEET
 RECEIVE ANTENNA HEIGHT: .0 FEET
 TRANSMITTER POWER: 100.0 WATTS
 REQUIRED BANDWIDTH: 2.8 KHZ
 REQUIRED SIGNAL TO NOISE: 12.0 dB
 TERRAIN: SE
 SURFACE COVER: //
 SURFACE CONDUCTIVITY: .40E+01 MHO/M
 DIELECTRIC: 81.00
 WIND VELOCITY: 25.0 KNOTS
 MANMADE NOISE MODEL: SH
 ATMOSPHERIC NOISE: YES
 CALCULATED GROUNDWAVE LOSS: 104.59 dB
 REQUIRED POWER: 56.573 WATTS
 AVAILABLE POWER: 100.000 WATTS
 MAX RANGE FOR POWER OF 100.000 WATTS: 115.4 NMI
 NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi
 GW>

*** UNCLASSIFIED ***

DATE: 1/ 1 AT 18:00 UT

GROUNDWAVE IS FROM HELO2 ON: 8.984 MHZ
RANGE TO RECEIVER NFOLK IS: 198.9 NMI
TRANSMIT GROUNDWAVE GAIN: .0 dBi
POLARIZATION: V
TRANSMIT ANTENNA HEIGHT: 500.0 FEET
RECEIVE ANTENNA HEIGHT: .0 FEET
TRANSMITTER POWER: 100.0 WATTS
REQUIRED BANDWIDTH: 2.8 KHZ
REQUIRED SIGNAL TO NOISE: 12.0 dB
TERRAIN: SE
SURFACE COVER: //
SURFACE CONDUCTIVITY: .40E+01 MHO/M
DIELECTRIC: 81.00
WIND VELOCITY: 25.0 KNOTS
MANMADE NOISE MODEL: SH
ATMOSPHERIC NOISE: YES
CALCULATED GROUNDWAVE LOSS: 127.36 dB
REQUIRED POWER: 10712.970 WATTS
AVAILABLE POWER: 100.000 WATTS

— ** SURFACE WAVE PROPAGATION TO RECEIVER NFOLK UNLIKELY **

MAX RANGE FOR POWER OF 100.000 WATTS: 115.4 NMI

NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi

GW)

SELECT DISPLAY OPTION (A/F/P/E)

GW>a

*** UNCLASSIFIED *** DATE: 1/ 1 AT 18:00 UT

GROUNDWAVE IS FROM HELO4	ON:	8.984 MHZ
RANGE TO RECEIVER NFOLK	IS:	47.7 NMI
TRANSMIT GROUNDWAVE GAIN:		.0 dBi
POLARIZATION:		V
TRANSMIT ANTENNA HEIGHT:		500.0 FEET
RECEIVE ANTENNA HEIGHT:		.0 FEET
TRANSMITTER POWER:		100.0 WATTS
REQUIRED BANDWIDTH:		2.8 KHZ
REQUIRED SIGNAL TO NOISE:		12.0 dB
TERRAIN:		SE
SURFACE COVER:		//
SURFACE CONDUCTIVITY:		.40E+01 MHO/M
DIELECTRIC:		81.00
WIND VELOCITY:		25.0 KNOTS
MANMADE NOISE MODEL:		SH
ATMOSPHERIC NOISE:		YES
CALCULATED GROUNDWAVE LOSS:		86.77 dB
REQUIRED POWER:		.934 WATTS
AVAILABLE POWER:		100.000 WATTS

MAX RANGE FOR POWER OF 100.000 WATTS: 115.4 NMI

NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi

GW>

ON UNCLASSIFIED ***

REF: REL01 36-0 0 N 74-30-0 0 001: 0

CON: NOLK 36-40-12 N 76-31-0 0 001: 149 RANGE: 100.0 001

OFF: 7/1/86 SSF: 500.0 RP3: 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0

RC SOURCES: XRAY=DEFAULT RP=DEFAULT SSQ=DEFAULT

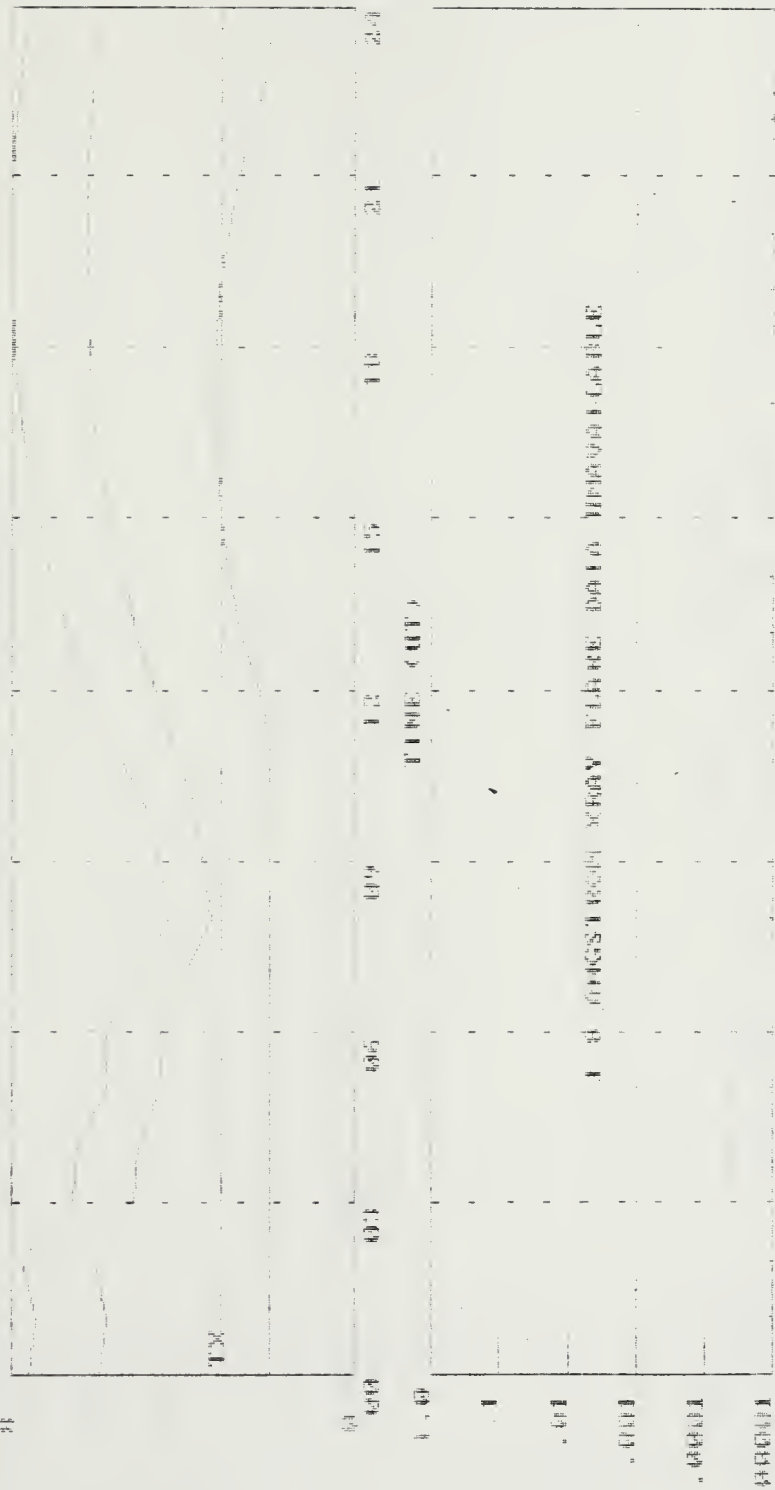
END: 3.12.1982

74-30-0 0 001: 0

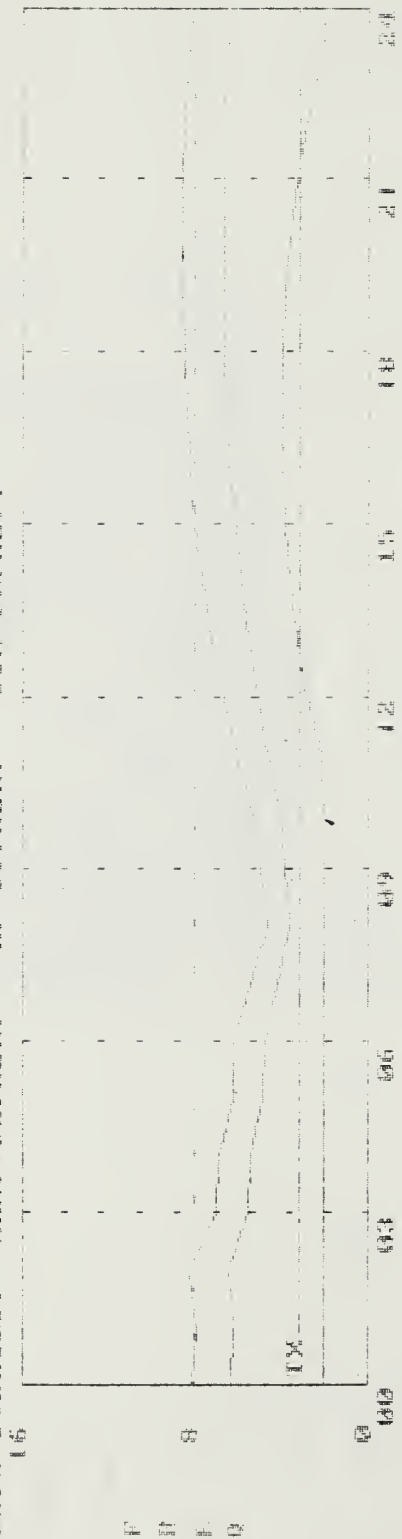
76-31-0 0 001: 149 RANGE: 100.0 001

RP3: 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0

RP=DEFAULT SSQ=DEFAULT



*** UNCLASSIFIED ***
 NAME: HEL02 36-0-0 H 72-30-0 H 0HT: 0
 CODE: HEOLK 36-40-12 H 76-31-40 H 0HT: 144 RANGE: 198.9 NM
 DATE: 7/1/86 SSN: 590 H RPS: 1.0 1.0 1.0 1.0 1.0 1.0 1.0
 DATA SOURCES: XRAY=DEFAULT RF=DEFAULT SSN=DEFAULT



*** UNCLASSIFIED ***

XMR: HEL04 36-0-0 N

RCMR: MEOLK 36-40-12 N

DATE: 7/1/86 SSN= 50.0

DATA SOURCES: XRAY=DEFAULT

FREQ: 3.40 MHZ

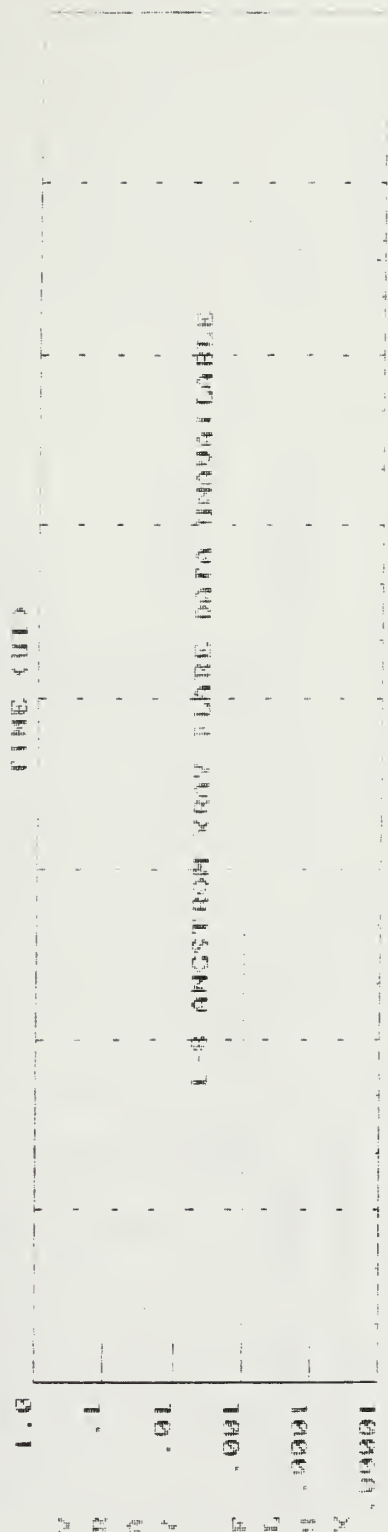
76-0 0 0 0

76-31-08 4 0MT: 182

RP3= 1.0 1.0 1.0 1.0 1.0 1.0

RP=DEFAULT SSN=DEFAULT

47.7 MHz



1-8 ANGSTROM XRAY FILRE DATA UNAVAILABLE

CLARK COLLEGE BOOKS, INC. 1445 OGDEN

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Figure 1

(a) **Flowchart illustrating the study design.**

(b) **Flowchart illustrating the study design.**

(c) **Flowchart illustrating the study design.**

(d) **Flowchart illustrating the study design.**

(e) **Flowchart illustrating the study design.**

(f) **Flowchart illustrating the study design.**

(g) **Flowchart illustrating the study design.**

(h) **Flowchart illustrating the study design.**

(i) **Flowchart illustrating the study design.**

(j) **Flowchart illustrating the study design.**

(k) **Flowchart illustrating the study design.**

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(m) **Flowchart illustrating the study design.**

(n) **Flowchart illustrating the study design.**

(o) **Flowchart illustrating the study design.**

(p) **Flowchart illustrating the study design.**

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(v) **Flowchart illustrating the study design.**

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(x) **Flowchart illustrating the study design.**

(y) **Flowchart illustrating the study design.**

(z) **Flowchart illustrating the study design.**

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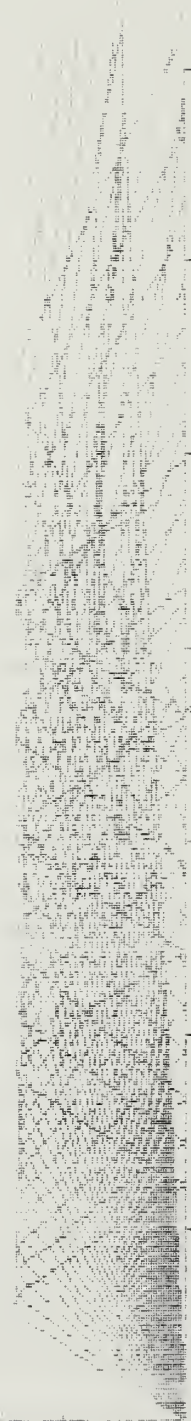
DATE: 7/1/86 TIME: 09:00 HZ GROUNDWATER NOISE: YES
VIB: 3.1 SSN: 50.0 RP: 1.0 MPT MADE NOISE: NO
VIB: HELOR 36-0-0 HZ 72-30-0 HZ ANT: 40 HZ ANT: 40 HZ
VIB: HELOR 36-00-12 HZ 72-31-18 HZ ANT: 149 HZ 1.5 HZ ANT: 198.9 HZ
GROUSE: FOF: 1.1 HZ FOF: 1.5 HZ FOF: 1.5 HZ FOF: 1.5 HZ
VIB: 350. HZ VIB: 102.5 HZ



THROUGATING NOISE

MAX NOISE RELATIVE: 3

FACH TEC: 100 HZ



NOISE

LAUNCH CIRCLES: STAFF

1.00 HZ 17.00 HZ 2.00 HZ

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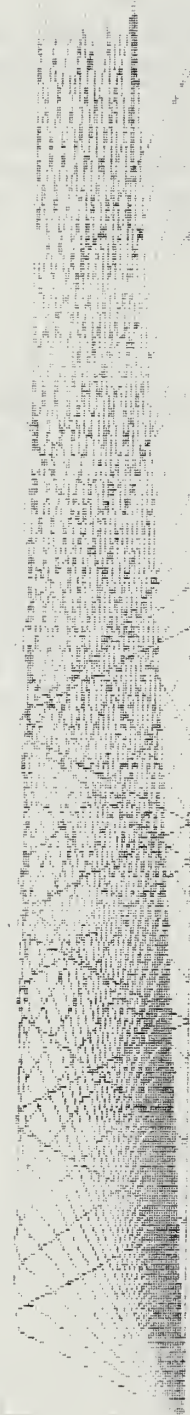
ADVANCED PROPHET RAYTRACE SYNOPSIS

DATE: 7/ 1/86 TIME: 09:00 UT ATMOSPHERIC NOISE: YES BWIDTH: 2.800 KHZ
FREQ: 3.1 SSN: 50.0 KP: 1.0 MAN-MADE NOISE: SH SNR REQD: 12.0 DB
XMTR: HELO2 36- 0- 0 N 72-30- 0 W ANT: 0 @ *OMNI* PWR: 100.00
RCVR: NFOLK 36-40-12 N 76-31-48 W ANT: 144 @ 1.5 RANGE: 198.9 NMI
IONOSPHERE: FOF= 1.1 MHZ FOF1= 1.6 MHZ FOF2= 4.4
HMF2= 350. KM YMF2=102.5 KM

NHOP	1	2	3	0	0	0
MODE	3000000	3300000	3330000	0000000	0000000	0000000
ANGLE	58.55	73.45	78.90	.00	.00	.00
DELAY(MSEC)	2.464	4.520	6.680	.000	.000	.000
LOSS(DB)	100.75	111.05	117.88	.00	.00	.00
GAIN TX/RX	0/-10	0/-10	0/-10	0/ 0	0/ 0	0/ 0
1HZ SNR(DB)	47.14	36.84	30.01	.00	.00	.00
ADJ SNR(DB)	12.67	2.37	-4.46	.00	.00	.00
VIR HT1 (KM)	318.94	327.98	330.85	.00	.00	.00
VIR HT2 (KM)	.00	324.94	328.79	.00	.00	.00
VIR HT3 (KM)	.00	.00	326.92	.00	.00	.00

RA>

0001 : 77 186 TIME: 09:04 BT 4 POSITIVE POSER: YES
 0002 : 50 50 50 50 50 50 50 50 50 50 50 50 50 50
 0003 : NEOL 36-0-0 4 76-31 4 11 000 0 0 0000 0
 0004 : NEOL 36-40-12 4 76-31 4 11 000 14 0 000 0
 0005 : PURE: 000 1.1 000 101 1.6 000 1000 0
 0006 : 0002=350. 000 000 0.02 0 000

PROPAGATING HOLES
444 HOLES ALLOWED
5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039 
$$H^1(\mathcal{V}^{\text{an}}) \cong H^1(\mathcal{V}^{\text{an}}) \oplus H^1(\mathcal{V}^{\text{an}}) \oplus \dots \oplus H^1(\mathcal{V}^{\text{an}}) \oplus H^1(\mathcal{V}^{\text{an}}) \oplus \dots \oplus H^1(\mathcal{V}^{\text{an}}) \oplus H^1(\mathcal{V}^{\text{an}}) \oplus \dots$$

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ADVANCED PROPHET RAYTRACE SYNOPSIS

DATE: 7/ 1/86 TIME: 09:00 UT ATMOSPHERIC NOISE: YES BWIDTH: 2.800 KHZ
FREQ: 3.1 SSN: 50.0 KP: 1.0 MAN-MADE NOISE: SH SNR REQD: 12.0 DB
XMTR: HELO1 36- 0- 0 N 74-30- 0 W ANT: 0 @ *OMNI* PWR: 100.00
RCVR: NFOLK 36-40-12 N 76-31-48 W ANT: 144 @ 1.5 RANGE: 106.0 NMI
IONOSPHERE: FOF= 1.1 MHZ FOF1= 1.6 MHZ FOF2= 4.4
HMF2= 350. KM YMF2=102.4 KM

NHOP	1	2	3	0	0	0
MODE	3000000	3300000	3330000	0000000	0000000	0000000
ANGLE	72.30	81.05	84.00	.00	.00	.00
DELAY(MSEC)	2.261	4.421	6.603	.000	.000	.000
LOSS(DB)	99.23	110.94	117.98	.00	.00	.00
GAIN TX/RX	0/-10	0/-10	0/-10	0/ 0	0/ 0	0/ 0
1HZ SNR(DB)	48.66	36.95	29.91	.00	.00	.00
ADJ SNR(DB)	14.19	2.48	-4.56	.00	.00	.00
VIR HT1(KM)	324.54	329.30	330.22	.00	.00	.00
VIR HT2(KM)	.00	327.55	329.13	.00	.00	.00
VIR HT3(KM)	.00	.00	328.08	.00	.00	.00
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*** UNCLASSIFIED ***

ADVANCED PROPHET RAYTRACE SYNOPSIS

DATE: 7/ 1/86 TIME: 09:00 UT ATMOSPHERIC NOISE: YES BWIDTH: 2.800 KHZ
 FREQ: 3.0 SSN: 50.0 KP: 1.0 MAN-MADE NOISE: SH SNR REQD: 12.0 DB
 XMTR: HELO4 36- 0- 0 N 76- 0- 0 W ANT: 0 @ *OMNI* PWR: 100.00
 RCVR: NFOLK 36-40-12 N 76-31-48 W ANT: 182 @ *OMNI* RANGE: 47.7 NMI
 IONOSPHERE: FOF1= 1.1 MHZ FOF2= 1.6 MHZ FOF3= 4.4
 HMF2= 350. KM YMF2=102.3 KM

NHOP	1	2	0	0	0	0
MODE	3000000	3300000	0000000	0000000	0000000	0000000
ANGLE	81.80	85.90	.00	.00	.00	.00
DELAY(MSEC)	2.170	4.318	.000	.000	.000	.000
LOSS(DB)	98.37	110.40	.00	.00	.00	.00
GAIN TX/RX	0/-40	0/-40	0/ 0	0/ 0	0/ 0	0/ 0
1HZ SNR(DB)	18.81	6.78	.00	.00	.00	.00
ADJ SNR(DB)	-15.66	-27.69	.00	.00	.00	.00
VIR HT1(KM)	322.98	324.06	.00	.00	.00	.00
VIR HT2(KM)	.00	323.39	.00	.00	.00	.00
VIR HT3(KM)	.00	.00	.00	.00	.00	.00

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*** UNCLASSIFIED *** DATE: 7/ 1 AT 09:00 UT
 GROUNDWAVE IS FROM HELO1 ON: 3.123 MHZ
 RANGE TO RECEIVER NFOLK IS: 106.0 NMI
 TRANSMIT GROUNDWAVE GAIN: .0 dBi
 POLARIZATION: V
 TRANSMIT ANTENNA HEIGHT: 500.0 FEET
 RECEIVE ANTENNA HEIGHT: .0 FEET
 TRANSMITTER POWER: 100.0 WATTS
 REQUIRED BANDWIDTH: 2.8 KHZ
 REQUIRED SIGNAL TO NOISE: 12.0 dB
 TERRAIN: SE
 SURFACE COVER: //
 SURFACE CONDUCTIVITY: .40E+01 MHO/M
 DIELECTRIC: 81.00
 WIND VELOCITY: 25.0 KNOTS
 MANMADE NOISE MODEL: SH
 ATMOSPHERIC NOISE: YES
 CALCULATED GROUNDWAVE LOSS: 83.49 dB
 REQUIRED POWER: 14.832 WATTS
 AVAILABLE POWER: 100.000 WATTS
 MAX RANGE FOR POWER OF 100.000 WATTS: 160.1 NMI
 NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi
 GW>

*** UNCLASSIFIED *** DATE: 7/ 1 AT 09:00 UT
 GROUNDWAVE IS FROM HELO2 ON: 3.123 MHZ
 RANGE TO RECEIVER NFOLK IS: 198.9 NMI
 TRANSMIT GROUNDWAVE GAIN: .0 dBi
 POLARIZATION: V
 TRANSMIT ANTENNA HEIGHT: 500.0 FEET
 RECEIVE ANTENNA HEIGHT: .0 FEET
 TRANSMITTER POWER: 100.0 WATTS
 REQUIRED BANDWIDTH: 2.8 KHZ
 REQUIRED SIGNAL TO NOISE: 12.0 dB
 TERRAIN: SE
 SURFACE COVER: //
 SURFACE CONDUCTIVITY: .40E+01 MHO/M
 DIELECTRIC: 81.00
 WIND VELOCITY: 25.0 KNOTS
 MANMADE NOISE MODEL: SH
 ATMOSPHERIC NOISE: YES
 CALCULATED GROUNDWAVE LOSS: 97.03 dB
 REQUIRED POWER: 288.807 WATTS
 AVAILABLE POWER: 100.000 WATTS

** SURFACE WAVE PROPAGATION TO RECEIVER NFOLK UNLIKELY **

MAX RANGE FOR POWER OF 100.000 WATTS: 164.8 NMI

NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi

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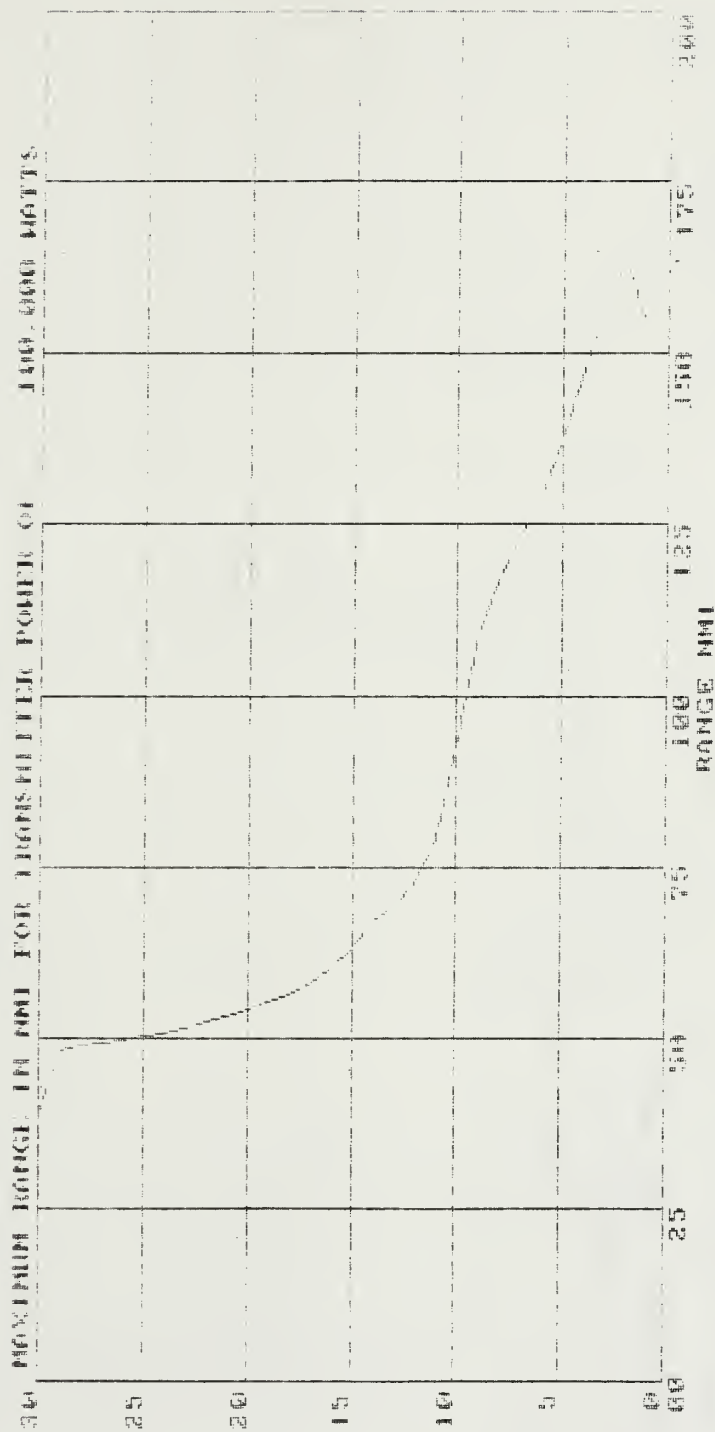
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*** UNCLASSIFIED *** DATE: 7/ 1 AT 09:00 UT
GROUNDWAVE IS FROM HELO4 ON: 3.000 MHZ
RANGE TO RECEIVER NFOLK IS: 47.7 NMI
TRANSMIT GROUNDWAVE GAIN: .0 dBi
 POLARIZATION: V
TRANSMIT ANTENNA HEIGHT: 500.0 FEET
RECEIVE ANTENNA HEIGHT: .0 FEET
TRANSMITTER POWER: 100.0 WATTS
REQUIRED BANDWIDTH: 2.8 KHZ
REQUIRED SIGNAL TO NOISE: 12.0 dB
 TERRAIN: SE
 SURFACE COVER: //
SURFACE CONDUCTIVITY: .40E+01 MHO/M
 DIELECTRIC: 81.00
 WIND VELOCITY: 25.0 KNOTS
MANMADE NOISE MODEL: SH
 ATMOSPHERIC NOISE: YES
CALCULATED GROUNDWAVE LOSS: 72.41 dB
 REQUIRED POWER: 1.450 WATTS
 AVAILABLE POWER: 100.000 WATTS
MAX RANGE FOR POWER OF 100.000 WATTS: 157.5 NMI
NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi
GW>

*** UNCLASSIFIED ***

CHCINDUAVE ANALYSIS FOR DATE: 74 1/86 TIME: 09:00 UT
 XMTFR: HELIX POLARIZATION: 0 POWER: 100.000 WATTS
 RCUR: HEOLK FREQUENCY: 3.000 MHZ RANGE: 47.7 NM
 ANTENNA HEIGHT XMTFR: 500.0 FEET RCUR: .0 FEET
 TARRAIN: SE COVER: // WIND: 25.0 KNOTS ATMOSPHERIC NOISE: YES
 DIELECTRIC: 81.0 SURFACE CONDUCTIVITY: .40E+01 MUOM
 REED SNR: 12.0 DB BANDWIDTH: 2.800 KHZ MOINMDE NOISE: SH



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Figure 1: Schematic representation of the experimental design. The figure is divided into two main sections: 'Pretest' and 'Main Experiment'. The 'Pretest' section includes a 'Pretest' box with a 'Pretest' label and a 'Pretest' box with a 'Pretest' label. The 'Main Experiment' section includes a 'Main Experiment' box with a 'Main Experiment' label and a 'Main Experiment' box with a 'Main Experiment' label.

THE HISTORY OF THE UNITED STATES

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*** UNCLASSIFIED ***

AREA COVERAGE I DATE: 7/1/16 TIME: 09:10 UT

TRANSMITTER FREQUENCY: 5.70 MHz



85.0

LON: WEST

56.0

HELIX (X) COVERAGE - X

XXXXXXXXXX

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REF: 7/1/86 TIME: 09:00 UT ATMOSPHERIC NOISE: YES
SSN: 50.0 RP: 1.0 000 MHz NOISE: 50 SIN RPD: 12.0 dB
SSN: 36-0-0 74-30 0 4 000: 0 0 0000000000: 100.000
SSN: 36-00-12 76-31 0 4 000: 140 0 1.5 RANGE: 100.0 000
ATMOSPHERE: FOF1 1.6 MHz FOF2 4.8
UNIT2=350.00 UNIT2=100.6 RM

PROPAGATING MODES

MAX MODES ALLOWED

4 EACH FREQ 100 RM

NO. 100

LOCAL OFFICES: 5000

1.000 0000 0000

100.000 0000

[illegible][illegible]

PROPAGATING MODES

[illegible]

[illegible]

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DATE: 7/1/85 TIME: 09:00 UT ATMOSPHERIC NOISE: YES
REQD: 5.7 SSN: 50.0 RP: 1.0 MAN MADE NOISE: SH
CHTR: HELOC 36-0-0 N 76-0-0 ANT: 0 P 0 PH41 K AIR: 12.0 DB
7293: NEOLK 36-40-12 N 75-31-48 W ANT: 103.0 MHz RANGE: 100.00
INDICATED: FOF2= 1.1 MHZ FOF1= 1.6 MHZ FOF2-1.1
HMF2= 350. KM VME2= 102.3 KM

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PROPAGATING MODES      MAX MODES ALLOWED= 3      EACH FREQ = 1.00 MHz
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1. **Introduction**
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 217. **Figure 209**

*** UNCLASSIFIED *** DATE: 7/ 1 AT 09:00 UT
 GROUNDWAVE IS FROM HELO1 ON: 5.696 MHZ
 RANGE TO RECEIVER NFOLK IS: 106.0 NMI
 TRANSMIT GROUNDWAVE GAIN: .0 dBi
 POLARIZATION: V
 TRANSMIT ANTENNA HEIGHT: 500.0 FEET
 RECEIVE ANTENNA HEIGHT: .0 FEET
 TRANSMITTER POWER: 100.0 WATTS
 REQUIRED BANDWIDTH: 2.8 KHZ
 REQUIRED SIGNAL TO NOISE: 12.0 dB
 TERRAIN: SE
 SURFACE COVER: //
 SURFACE CONDUCTIVITY: .40E+01 MHO/M
 DIELECTRIC: 81.00
 WIND VELOCITY: 25.0 KNOTS
 MANMADE NOISE MODEL: SH
 ATMOSPHERIC NOISE: YES
 CALCULATED GROUNDWAVE LOSS: 93.53 dB
 REQUIRED POWER: 29.126 WATTS
 AVAILABLE POWER: 100.000 WATTS
 MAX RANGE FOR POWER OF 100.000 WATTS: 133.7 NMI
 NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi
 GW>

*** UNCLASSIFIED *** DATE: 7/ 1 AT 09:00 UT
 GROUNDWAVE IS FROM HELO2 ON: 5.696 MHZ
 RANGE TO RECEIVER NFOLK IS: 198.9 NMI
 TRANSMIT GROUNDWAVE GAIN: .0 dBi
 POLARIZATION: V
 TRANSMIT ANTENNA HEIGHT: 500.0 FEET
 RECEIVE ANTENNA HEIGHT: .0 FEET
 TRANSMITTER POWER: 100.0 WATTS
 REQUIRED BANDWIDTH: 2.8 KHZ
 REQUIRED SIGNAL TO NOISE: 12.0 dB
 TERRAIN: SE
 SURFACE COVER: //
 SURFACE CONDUCTIVITY: .40E+01 MHO/M
 DIELECTRIC: 81.00
 WIND VELOCITY: 25.0 KNOTS
 MANMADE NOISE MODEL: SH
 ATMOSPHERIC NOISE: YES
 CALCULATED GROUNDWAVE LOSS: 110.23 dB
 REQUIRED POWER: 1222.074 WATTS
 AVAILABLE POWER: 100.000 WATTS
 ** SURFACE WAVE PROPAGATION TO RECEIVER NFOLK UNLIKELY **
 MAX RANGE FOR POWER OF 100.000 WATTS: 136.3 NMI
 NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi
 GW)

SELECT DISPLAY OPTION (A/F/P/E)

GW>a

*** UNCLASSIFIED *** DATE: 7/ 1 AT 09:00 UT

GROUNDWAVE IS FROM HELO4	ON:	5.696 MHZ
RANGE TO RECEIVER NFOLK	IS:	47.7 NMI
TRANSMIT GROUNDWAVE GAIN:		.0 dBi
POLARIZATION:		V
TRANSMIT ANTENNA HEIGHT:		500.0 FEET
RECEIVE ANTENNA HEIGHT:		.0 FEET
TRANSMITTER POWER:		100.0 WATTS
REQUIRED BANDWIDTH:		2.8 KHZ
REQUIRED SIGNAL TO NOISE:		12.0 dB
TERRAIN:		SE
SURFACE COVER:		//
SURFACE CONDUCTIVITY:		.40E+01 MHO/M
DIELECTRIC:		81.00
WIND VELOCITY:		25.0 KNOTS
MANMADE NOISE MODEL:		SH
ATMOSPHERIC NOISE:		YES
CALCULATED GROUNDWAVE LOSS:		79.52 dB
REQUIRED POWER:		1.259 WATTS
AVAILABLE POWER:		100.000 WATTS
MAX RANGE FOR POWER OF	100.000 WATTS:	131.7 NMI

NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi

GW>

SECRET

*** UNCLASSIFIED ***
 AREA COVERAGE 1 DATE: 7/1/86 TIME: 18:00 UT
 TRANSMITTER FREQUENCY: 5.74 MHz



95.4 100.4 105.4 110.4 115.4 120.4 125.4 130.4 135.4 140.4 145.4 150.4 155.4 160.4 165.4 170.4 175.4 180.4 185.4 190.4 195.4 200.4 205.4 210.4 215.4 220.4 225.4 230.4 235.4 240.4 245.4 250.4 255.4 260.4 265.4 270.4 275.4 280.4 285.4 290.4 295.4 300.4 305.4 310.4 315.4 320.4 325.4 330.4 335.4 340.4 345.4 350.4 355.4 360.4 365.4 370.4 375.4 380.4 385.4 390.4 395.4 400.4 405.4 410.4 415.4 420.4 425.4 430.4 435.4 440.4 445.4 450.4 455.4 460.4 465.4 470.4 475.4 480.4 485.4 490.4 495.4 500.4 505.4 510.4 515.4 520.4 525.4 530.4 535.4 540.4 545.4 550.4 555.4 560.4 565.4 570.4 575.4 580.4 585.4 590.4 595.4 600.4 605.4 610.4 615.4 620.4 625.4 630.4 635.4 640.4 645.4 650.4 655.4 660.4 665.4 670.4 675.4 680.4 685.4 690.4 695.4 700.4 705.4 710.4 715.4 720.4 725.4 730.4 735.4 740.4 745.4 750.4 755.4 760.4 765.4 770.4 775.4 780.4 785.4 790.4 795.4 800.4 805.4 810.4 815.4 820.4 825.4 830.4 835.4 840.4 845.4 850.4 855.4 860.4 865.4 870.4 875.4 880.4 885.4 890.4 895.4 900.4 905.4 910.4 915.4 920.4 925.4 930.4 935.4 940.4 945.4 950.4 955.4 960.4 965.4 970.4 975.4 980.4 985.4 990.4 995.4 1000.4

UNCLASSIFIED FOR

1 AREA COVERAGE 1 DATE: 7/1/66 TIME: 18:00 UT

TRANSMITTER FREQUENCY: 5.73 MHZ



05.0 LON: WEST 66.4

06.0 (a) COVERAGE = X

07.0 (b) COVERAGE = X

08.0

ENCLOSURE

REF: 7/1/66 TIME: 10:00 HZ: 100.000000
TIME: 5.7 SEC: 30.0 EP: 1.0 NON-MODE NOISE: SN SNR: 12.0 DB
MODE: HELIX 36-0 0 H 14-30-0 H OUT: 0 P 3000000 MHz: 100.000
MODE: HELIX 36-40 12 H 16-31-0 H OUT: 144 P 1.5 RANGE: 106.0 MHz
CONSPHERE: FOF2 3.5 MHz FOF1 4.9 MHz FOF2 7.5
MODE: 250. MHz MODE: 119.5 MHz

PROPAGATING MODES

MAX MODES ALLOWED

FOF1 FOF2 FOF3 FOF4

RAYFAN

LAUNCH ANGLES: START

1.000 10.000 100.000

2.400

*** UNCLASSIFIED ***

ADVANCED PROPHET RAYTRACE SYNOPSIS

DATE: 7/ 1/86 TIME: 18:00 UT ATMOSPHERIC NOISE: YES BWIDTH: 2.800 KHZ
 FREQ: 5.7 SSN: 50.0 KP: 1.0 MAN-MADE NOISE: SH SNR REQD: 12.0 DB
 XMTR: HELO1 36- 0- 0 N 74-30- 0 W ANT: 0 @ *OMNI* PWR: 100.00
 RCVR: NFOLK 36-40-12 N 76-31-48 W ANT: 144 @ 1.5 RANGE: 106.0 NMI
 IONOSPHERE: FOF= 3.5 MHZ FOF1= 4.9 MHZ FOF2= 7.5
 HMF2= 253. KM YMF2=119.8 KM

NHOP	1	2	3	0	0	0
MODE	3000000	3300000	3330000	0000000	0000000	0000000
ANGLE	65.30	77.55	81.70	.00	.00	.00
DELAY(MSEC)	1.619	3.144	4.703	.000	.000	.000
LOSS(DB)	119.51	146.65	169.86	.00	.00	.00
GAIN TX/RX	0/-11	0/-11	0/-13	0/ 0	0/ 0	0/ 0
1HZ SNR(DB)	37.84	10.70	-14.51	.00	.00	.00
ADJ SNR(DB)	3.37	-23.77	-48.98	.00	.00	.00
VIR HT1(KM)	222.03	231.26	233.63	.00	.00	.00
VIR HT2(KM)	.00	230.93	233.40	.00	.00	.00
VIR HT3(KM)	.00	.00	233.20	.00	.00	.00
RAJ						

UNCLASSIFIED ***

DATE: 7/1/86 TIME: 18:00 UT ATMOSPHERE: NOISE: YES
 UHF: 5.7 SSN: 50.0 RP: 1.0 MIN MAX NOISE: 50
 CENTER: HEL02 36-0-0 N 72-30-0 W AUT: 00.0000000000
 HGT: NEOLH 36-40-12 N 76-31-40 W AUT: 149.0 1.0 RANGE: 198.9 NM
 ATMOSPHERE: FOF2= 3.5 MHz FOF1= 4.0 MHz FOF3= 7.5
 MUF2= 25.0 MHz M3000= 119.7 MHz

150

PROPAGATING MODES MAX MODES ALLOWED: 3 EACH TIC: 100 NM



RAYFAN LAUNCH ANGLES: START= 1.00 END= 27.00 INC= 2.000



*** UNCLASSIFIED ***

ADVANCED PROPHET RAYTRACE SYNOPSIS

DATE: 7/ 1/86 TIME: 18:00 UT ATMOSPHERIC NOISE: YES BWIDTH: 2.800 KHZ
 FREQ: 5.7 SSN: 50.0 KP: 1.0 MAN-MADE NOISE: SH SNR REQD: 12.0 DB
 XMTR: HELO2 36- 0- 0 N 72-30- 0 W ANT: 0 @ *OMNI* PWR: 100.00
 RCVR: NFOLK 36-40-12 N 76-31-48 W ANT: 144 @ 1.5 RANGE: 198.9 NMI
 IONOSPHERE: FOF= 3.5 MHZ FOF1= 4.9 MHZ FOF2= 7.5
 HMF2= 253. KM YMF2=119.7 KM

NHOP	1	1	1	0	0	0
MODE	1000000	1000000	2000000	0000000	0000000	0000000
ANGLE	29.90	36.80	44.45	.00	.00	.00
DELAY (MSEC)	1.443	1.537	1.768	.000	.000	.000
LOSS (DB)	135.38	149.81	123.57	.00	.00	.00
GAIN TX/RX	0/-10	0/ -8	0/ -8	0/ 0	0/ 0	0/ 0
1HZ SNR (DB)	22.98	10.55	36.79	.00	.00	.00
ADJ SNR (DB)	-11.49	-23.92	2.32	.00	.00	.00
VIR HT1 (KM)	110.53	140.81	188.80	.00	.00	.00
VIR HT2 (KM)	.00	.00	.00	.00	.00	.00
VIR HT3 (KM)	.00	.00	.00	.00	.00	.00
RA>						

*** UNCLASSIFIED ***

DATE: 7/1/86 TIME: 18:00 UT ATMOSPHERIC NOISE: YES
 SSN: 50.0 RP: 1.9 HAM MODE NOISE: ON
 HELIX: 36 9-0 N 76-0-0 W ANT: 0 0 WOHM 14
 NEOLK 36 10-12 N 76-31-48 W ANT: 100 0 WOHM 14
 LANDSPHERE: FREQ: 3.5 MHz FOF2: 4.9 MHz FOF2: 7.7
 HNF2: 253. KM VMEP: 113.3 KM

SWR REFL: 12.0 DB
 PWR: 193.00
 RANGE: 47.7 NM



PROPAGATING MODES MAX MODES ALLOWED: 3 CATH T10: 100 KM

ROVEAU LAUNCH ANGLES: START 1.00 END 0.00 INCL 0.00

*** UNCLASSIFIED ***

ADVANCED PROPHET RAYTRACE SYNOPSIS

DATE: 7/ 1/86 TIME: 18:00 UT ATMOSPHERIC NOISE: YES BWIDTH: 2.800 KHZ
 FREQ: 5.7 SSN: 50.0 KP: 1.0 MAN-MADE NOISE: SH SNR REQD: 12.0 DB
 XMTR: HELO4 36- 0- 0 N 76- 0- 0 W ANT: 0 @ *OMNI* PWR: 100.00
 RCVR: NFOLK 36-40-12 N 76-31-48 W ANT: 182 @ *OMNI* RANGE: 47.7 NMI
 IONOSPHERE: FOF1= 3.5 MHZ FOF2= 4.9 MHZ FOF2= 7.5
 HMF2= 253. KM YMF2=119.8 KM

NHOP	1	2	3	0	0	0
MODE	3000000	3300000	3330000	0000000	0000000	0000000
ANGLE	78.80	84.40	86.30	.00	.00	.00
DELAY(MSEC)	1.569	3.129	4.691	.000	.000	.000
LOSS(DB)	117.78	146.13	169.58	.00	.00	.00
GAIN TX/RX	0/-18	0/-40	0/-40	0/ 0	0/ 0	0/ 0
1HZ SNR(DB)	32.33	-18.03	-41.47	.00	.00	.00
ADJ SNR(DB)	-2.14	-52.50	-75.94	.00	.00	.00
VIR HT1(KM)	231.61	234.27	234.80	.00	.00	.00
VIR HT2(KM)	.00	234.21	234.75	.00	.00	.00
VIR HT3(KM)	.00	.00	234.69	.00	.00	.00

RA>

*** UNCLASSIFIED *** DATE: 7/ 1 AT 18:00 UT
 GROUNDWAVE IS FROM HELO1 ON: 5.696 MHZ
 RANGE TO RECEIVER NFOLK IS: 106.0 NMI
 TRANSMIT GROUNDWAVE GAIN: .0 dBi
 POLARIZATION: V
 TRANSMIT ANTENNA HEIGHT: 500.0 FEET
 RECEIVE ANTENNA HEIGHT: .0 FEET
 TRANSMITTER POWER: 100.0 WATTS
 REQUIRED BANDWIDTH: 2.8 KHZ
 REQUIRED SIGNAL TO NOISE: 12.0 dB
 TERRAIN: SE
 SURFACE COVER: //
 SURFACE CONDUCTIVITY: .40E+01 MHO/M
 DIELECTRIC: 81.00
 WIND VELOCITY: 25.0 KNOTS
 MANMADE NOISE MODEL: SH
 ATMOSPHERIC NOISE: YES
 CALCULATED GROUNDWAVE LOSS: 93.53 dB
 REQUIRED POWER: 15.454 WATTS
 AVAILABLE POWER: 100.000 WATTS
 MAX RANGE FOR POWER OF 100.000 WATTS: 148.7 NMI
 NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi
 GW>

*** UNCLASSIFIED *** DATE: 7/ 1 AT 18:00 UT
 GROUNDWAVE IS FROM HELO2 ON: 5.696 MHZ
 RANGE TO RECEIVER NFOLK IS: 198.9 NMI
 TRANSMIT GROUNDWAVE GAIN: .0 dBi
 POLARIZATION: V
 TRANSMIT ANTENNA HEIGHT: 500.0 FEET
 RECEIVE ANTENNA HEIGHT: .0 FEET
 TRANSMITTER POWER: 100.0 WATTS
 REQUIRED BANDWIDTH: 2.8 KHZ
 REQUIRED SIGNAL TO NOISE: 12.0 dB
 TERRAIN: SE
 SURFACE COVER: //
 SURFACE CONDUCTIVITY: .40E+01 MHO/M
 DIELECTRIC: 81.00
 WIND VELOCITY: 25.0 KNOTS
 MANMADE NOISE MODEL: SH
 ATMOSPHERIC NOISE: YES
 CALCULATED GROUNDWAVE LOSS: 110.23 dB
 REQUIRED POWER: 723.544 WATTS
 AVAILABLE POWER: 100.000 WATTS
 ** SURFACE WAVE PROPAGATION TO RECEIVER NFOLK UNLIKELY **
 MAX RANGE FOR POWER OF 100.000 WATTS: 148.8 NMI
 NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi
 GW>

SELECT DISPLAY OPTION (A/F/P/E)

GW>a

*** UNCLASSIFIED ***

DATE: 7/ 1 AT 18:00 UT

GROUNDWAVE IS FROM HELO4 ON: 5.696 MHZ

RANGE TO RECEIVER NFOLK IS: 47.7 NMI

TRANSMIT GROUNDWAVE GAIN: .0 dBi

POLARIZATION: V

TRANSMIT ANTENNA HEIGHT: 500.0 FEET

RECEIVE ANTENNA HEIGHT: .0 FEET

TRANSMITTER POWER: 100.0 WATTS

REQUIRED BANDWIDTH: 2.8 KHZ

REQUIRED SIGNAL TO NOISE: 12.0 dB

TERRAIN: SE

SURFACE COVER: //

SURFACE CONDUCTIVITY: .40E+01 MHO/M

DIELECTRIC: 81.00

WIND VELOCITY: 25.0 KNOTS

MANMADE NOISE MODEL: SH

ATMOSPHERIC NOISE: YES

CALCULATED GROUNDWAVE LOSS: 79.52 dB

REQUIRED POWER: .614 WATTS

AVAILABLE POWER: 100.000 WATTS

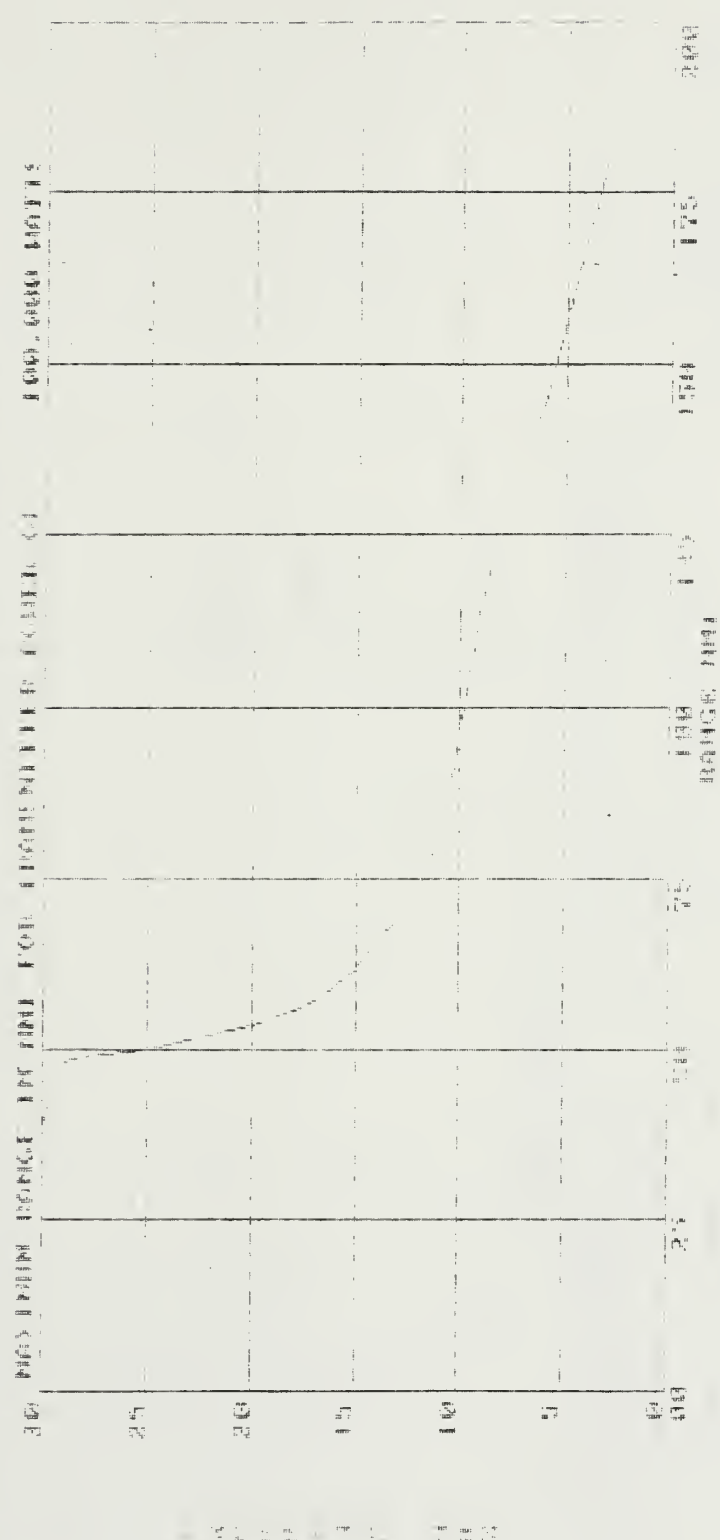
MAX RANGE FOR POWER OF 100.000 WATTS: 148.7 NMI

NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi

GW>

*** UNCLASSIFIED ***

GROUNDWATER ANALYSIS FOR DATE: 7/1/80 TIME: 18:00 H
SITE: HELLO4 POLARIZATION: 0 POWER: 100.000 HATS
STUDY: HELLO4 FREQUENCY: 5.600 MHZ RANGE: 47.7 HAT
ANTENNA HEIGHT: 500.0 FEET ROOF: 1.0 FEET
ELEVATION: 85 COVER: 77 WIND: 25.0 KNOTS ATMOSPHERIC NOISE: YES
WETTER: 81.0 SURFACE CONDUCTIVITY: 100000 HAT/M
WET SURF: 10.0 DB BACKGROUND: 1.000 HATZ NOISE NOISE: 50



*** UNCLASSIFIED ***

1 AREA COVERAGE 1 DATE: 7/1/86 TIME: 18:00 H

TRANSMITTER FREQUENCY: 8.98 MHZ



86.0 66.0 LON: WEST

HEL01 (&) COVERAGE = X

CHROMAWARE

PAGE 1

[illegible]

Figure 1 is a schematic representation of the experimental design. It shows a sequence of events for each trial. The sequence starts with a 'Stimulus' phase, which includes a fixation cross and a face. This is followed by a 'Response' phase, where the subject presses a button. Finally, there is a 'Feedback' phase, which includes a light or sound. The sequence is repeated for multiple trials, labeled 'Trial 1', 'Trial 2', 'Trial 3', and 'Trial 4'.

1. $\frac{1}{2}$

10

*** UNCLASSIFIED *** DATE: 7/ 1 AT 18:00 UT
 GROUNDWAVE IS FROM HELO1 ON: 8.984 MHZ
 RANGE TO RECEIVER NFOLK IS: 106.0 NMI
 TRANSMIT GROUNDWAVE GAIN: .0 dBi
 POLARIZATION: V
 TRANSMIT ANTENNA HEIGHT: 500.0 FEET
 RECEIVE ANTENNA HEIGHT: .0 FEET
 TRANSMITTER POWER: 100.0 WATTS
 REQUIRED BANDWIDTH: 2.8 KHZ
 REQUIRED SIGNAL TO NOISE: 12.0 dB
 TERRAIN: SE
 SURFACE COVER: //
 SURFACE CONDUCTIVITY: .40E+01 MHO/M
 DIELECTRIC: 81.00
 WIND VELOCITY: 25.0 KNOTS
 MANMADE NOISE MODEL: SH
 ATMOSPHERIC NOISE: YES
 CALCULATED GROUNDWAVE LOSS: 104.59 dB
 REQUIRED POWER: 57.389 WATTS
 AVAILABLE POWER: 100.000 WATTS
 MAX RANGE FOR POWER OF 100.000 WATTS: 115.1 NMI
 NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi
 GW>

*** UNCLASSIFIED *** DATE: 7/ 1 AT 18:00 UT
 GROUNDWAVE IS FROM HELO2 ON: 8.984 MHZ
 RANGE TO RECEIVER NFOLK IS: 198.9 NMI
 TRANSMIT GROUNDWAVE GAIN: .0 dBi
 POLARIZATION: V
 TRANSMIT ANTENNA HEIGHT: 500.0 FEET
 RECEIVE ANTENNA HEIGHT: .0 FEET
 TRANSMITTER POWER: 100.0 WATTS
 REQUIRED BANDWIDTH: 2.8 KHZ
 REQUIRED SIGNAL TO NOISE: 12.0 dB
 TERRAIN: SE
 SURFACE COVER: //
 SURFACE CONDUCTIVITY: .40E+01 MHO/M
 DIELECTRIC: 81.00
 WIND VELOCITY: 25.0 KNOTS
 MANMADE NOISE MODEL: SH
 ATMOSPHERIC NOISE: YES
 CALCULATED GROUNDWAVE LOSS: 127.36 dB
 REQUIRED POWER: 10841.040 WATTS
 AVAILABLE POWER: 100.000 WATTS
 ** SURFACE WAVE PROPAGATION TO RECEIVER NFOLK UNLIKELY **
 MAX RANGE FOR POWER OF 100.000 WATTS: 115.2 NMI
 NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi
 GW>

SELECT DISPLAY OPTION (A/F/P/E)

GW>a

*** UNCLASSIFIED *** DATE: 7/ 1 AT 18:00 UT

GROUNDWAVE IS FROM HELO4 ON: 8.984 MHZ

RANGE TO RECEIVER NFOLK IS: 47.7 NMI

TRANSMIT GROUNDWAVE GAIN: .0 dBi

POLARIZATION: V

TRANSMIT ANTENNA HEIGHT: 500.0 FEET

RECEIVE ANTENNA HEIGHT: .0 FEET

TRANSMITTER POWER: 100.0 WATTS

REQUIRED BANDWIDTH: 2.8 KHZ

REQUIRED SIGNAL TO NOISE: 12.0 dB

TERRAIN: SE

SURFACE COVER: //

SURFACE CONDUCTIVITY: .40E+01 MHO/M

DIELECTRIC: 81.00

WIND VELOCITY: 25.0 KNOTS

MANMADE NOISE MODEL: SH

ATMOSPHERIC NOISE: YES

CALCULATED GROUNDWAVE LOSS: 86.77 dB

REQUIRED POWER: .949 WATTS

AVAILABLE POWER: 100.000 WATTS

MAX RANGE FOR POWER OF 100.000 WATTS: 115.1 NMI

NOTE: RECEIVE ANTENNA GROUNDWAVE GAIN ASSUMED = 0.0 dBi

GW>

GW67,1,10.87245,6.174135,1.413314,11.44021,6.174135,1.413314,.0254,
GW68,1,10.87245,7.55909,1.016869,11.44021,7.55909,1.016869,.0254,
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 GW261,1,7.790012,6.657393,1.840434,7.787118,5.940319,.1869372,.0254,
 GW262,2,7.009854,5.927586,7.813162E-02,7.787118,5.940319,.1869372,.0254,
 GW263,1,8.570171,6.532961,.2934277,8.576537,5.955945,.2934277,.0254,
 GW264,2,8.576537,5.955945,.2934277,7.787118,5.940319,.1869372,.0254,
 GW265,2,6.089637,5.029362,1.722368,6.093109,5.038622,.8768104,.0254,
 GW266,2,5.1509,4.926343,.8733379,6.093109,5.038622,.8768104,.0254,
 GW267,2,7.00696,5.147427,.8640779,7.000594,5.147427,1.684749,.0254,
 GW268,2,7.00696,5.147427,.8640779,6.093109,5.038622,.8768104,.0254,
 GW269,2,7.787118,5.250445,.8768104,7.790012,5.250445,1.644237,.0254,
 GW270,2,7.00696,5.147427,.8640779,7.787118,5.250445,.8768104,.0254,
 GW271,1,8.573065,5.353463,1.588098,8.579432,5.353463,.8704442,.0254,
 GW272,2,7.787118,5.250445,.8768104,8.579432,5.353463,.8704442,.0254,
 GW273,1,9.349752,6.411423,.4022332,9.349752,5.936846,.4022332,.0254,
 GW274,2,9.349752,5.936846,.4022332,8.576537,5.955945,.2934277,.0254,
 GW275,1,10.09229,5.550239,.5336101,10.0894,5.940319,.5336101,.0254,
 GW276,2,9.349752,5.936846,.4022332,10.0894,5.940319,.5336101,.0254,
 GW277,1,9.349752,5.453588,.8675504,9.349752,5.453588,1.534852,.0254,
 GW278,2,9.349752,5.453588,.8675504,8.579432,5.353463,.8704442,.0254,
 GW279,1,10.0894,5.550239,1.47582,10.09229,5.550239,.8704442,.0254,
 GW280,1,9.349752,5.453588,.8675504,10.09229,5.550239,.8704442,.0254,
 GW281,2,10.87245,5.653257,1.016869,10.09229,5.550239,.8704442,.0254,
 GW282,1,11.44021,5.784055,1.413314,11.44021,6.174135,1.413314,.0254,

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GW283,1,10.87245,6.174135,.6707745,10.87245,5.940319,.6707745,.0254,
GW284,2,10.87245,5.940319,.6707745,10.0894,5.940319,.5336101,.0254,
GW285,1,6.093109,5.393976,2.685992,6.096003,5.965205,2.685992,.0254,
GW286,1,7.009854,6.364544,2.685992,7.009854,5.958839,2.685992,.0254,
GW287,2,7.009854,5.958839,2.685992,6.096003,5.965205,2.685992,.0254,
GW288,1,5.425229,6.670126,2.685992,5.425229,5.977359,2.685992,.0254,
GW289,1,6.096003,5.965205,2.685992,5.968099,5.968099,2.685992,.0254,
GW290,1,5.425229,5.977359,2.685992,5.968099,5.968099,2.685992,.0254,
GW291,1,5.968099,5.968099,2.685992,5.968099,5.968099,2.885661,.0254,
GW292,12,5.968099,5.968099,2.885661,5.968099,11.9362,2.885661,.0254,
GW293,12,5.968099,5.968099,2.885661,5.968099,0.,2.885661,.0254,
GW294,12,5.968099,5.968099,2.885661,0.,5.968099,2.885661,.0254,
GW295,12,5.968099,5.968099,2.885661,11.9362,5.968099,2.885661,.0254,
GW296,1,7.790012,6.657393,.8733379,8.110642,6.606463,.8692867,.0254,
GW297,1,7.787118,6.657393,1.644237,8.112378,6.605884,1.622244,.0254,
GW298,2,8.110642,6.606463,.8692867,8.112378,6.605884,1.622244,.0254,
GW299,1,8.570171,6.532961,.2934277,8.10659,6.607042,.2286073,.0254,
GW300,1,8.110642,6.606463,.8692867,8.10659,6.607042,.2286073,.0254,
GW310,1,12.55083,5.933952,3.209763,12.74414,5.933952,3.506663,.0254,
GW320,2,13.47105,5.933952,2.162221,12.68163,5.933952,2.162221,.0254,
GW321,2,12.48543,6.174135,.4618447,12.58209,6.056069,1.298142,.0254,
GW322,2,12.68163,5.933952,2.162221,12.58209,6.056069,1.298142,.0254,
GW324,1,12.48543,6.174135,.4618447,12.48543,5.784055,.4618447,.0254,
GW326,1,12.21863,5.933952,2.70046,12.55083,5.933952,3.209763,.0254,
GW327,1,13.69271,5.784055,3.609681,13.63773,5.821674,3.249118,.0254,
*****GM 0,0,0,180 (MOVE UP @ GND) (ROTATE ABOUT Z AXIS)
*****GE (GEI FOR GROUND *** AND ADD GN AND GM CARDS)
*****FR 0,0,0,18.1,0

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WG

*****SPACE=12" LONGWIRE ANTENNA*****

NX

CM HH-65A DATA

CM CREATED 8/16/87

CM SPACE=12" LONGWIRE ANTENNA

CE

GF

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GW401,2,8.110642,6.606463,.8692867,8.18125,6.895364,1.617614,.0254,
GW402,5,11.94025,5.484158,1.413314,12.74414,5.634055,3.206869,.0254,
GW403,1,12.74414,6.233849,3.206869,12.74414,5.634055,3.206869,.0254,
GW404,8,8.187615,5.002636,1.615299,11.94025,5.484158,1.413314,.0254,
GW405,8,11.94025,6.474032,1.413314,8.18125,6.895364,1.617614,.0254,
GW406,5,11.94025,6.474032,1.413314,12.74414,6.233849,3.206869,.0254,
GM 0,0,0,180 (ROTATE ABOUT Z AXIS TO HEAD IN PHI=0)

```

GE

EX 0,402,3,01,1,0 (1 VOLT EXCITATION, ANT = TAG 402)

PL3, 2, 0,4

RP0, 1, 361, 1000, 90, 0, 0, 1 STD. HORIZONTAL PATTERN CUT

PL3, 2, 0,4

RP0, 1, 361, 1000, 26, 0, 0, 1 HORIZONTAL CUT, ELEVATION = 64 DEG

PL3, 1, 0,4

RP0, 361, 1, 1000, 0, 0, 1, 0 STD. VERTICAL PATTERN CUT

PL3, 1, 0,4

RP0, 361, 1, 1000, 0,45, 1, 0 VERT CUT AT PHI = 45 DEG

XQ

*****COLLINS 437R-2 ANTENNA*****

NX

CM H65 IGUANA DATA

CM COLLINS 437R-2 ANTENNA

CM STANDARD RADIATION PATTERNS

CE

GF

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GW401,3,8.110642,6.606463,.8692867,8.110642,7.063678,.8692867,.0254 ANT
GW402,15,8.110642,7.063678,.8692867,11.99986,5.99993,.1996697,.0254 ANT
GM 0,0,0,180 (ROTATE ABOUT Z AXIS TO HEAD IN PHI=0)

```

GE

EX 0,401,2,01,1,0 (1 VOLT EXCITATION, ANT = TAG 401)

PL3, 2, 0,4

RP0, 1, 361, 1000, 90, 0, 0, 1 STD. HORIZONTAL PATTERN CUT

PL3, 2, 0,4

RP0, 1, 361, 1000, 26, 0, 0, 1 HORIZONTAL CUT, ELEVATION = 64 DEG

PL3, 1, 0,4

RP0, 361, 1, 1000, 0, 0, 1, 0 STD. VERTICAL PATTERN CUT


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PL3, 1, 0, 4
RP0, 361, 1, 1000, 0, 45, 1, 0 VERT CUT AT PHI = 45 DEG
XQ
*****STANDARD TUBE INSTALLATION*****
NX
CM H65 IGUANA DATA CREATED 7/29/87
CM STANDARD TUBE ANTENNA
CE
GF
GW401, 1, 8.110642, 6.606463, .8692867, 8.110642, 6.860536, .8692867, .0254 ANT
GW402, 1, 11.44021, 6.174135, 1.413314, 11.44021, 6.428207, 1.413314, .0254 ANT
GW403, 14, 11.44021, 6.428207, 1.413314, 8.110642, 6.860536, .8692867, .0254 ANT
GM 0, 0, 0, 0, 180 (ROTATE ABOUT Z AXIS TO HEAD IN PHI=0)
GE
EX 0, 403, 13, 01, 1, 0 (1 VOLT EXCITATION, ANT = TAG 403)
PL3, 2, 0, 4
RP0, 1, 361, 1000, 90, 0, 0, 1 STD. HORIZONTAL PATTERN CUT
PL3, 2, 0, 4
RP0, 1, 361, 1000, 26, 0, 0, 1 HORIZONTAL CUT, ELEVATION = 64 DEG
PL3, 1, 0, 4
RP0, 361, 1, 1000, 0, 0, 1, 0 STD. VERTICAL PATTERN CUT
PL3, 1, 0, 4
RP0, 361, 1, 1000, 0, 45, 1, 0 VERT CUT AT PHI = 45 DEG
XQ
*****TRIVEC LONG TUBE INSTALLATION*****
NX
CM CREATED 7/30/87
CM LONG TRIVEC TUBE ANTENNA MODEL
CM EXCITATION ON SHORT STUB
CE
GF
GW401, 3, 8.110642, 6.860536, .8692867, 8.110642, 7.160329, .8692867, .0254 ANT
GW402, 14, 8.110642, 7.160329, .8692867, 11.44021, 6.728001, 1.413314, .0254 ANT
GW403, 2, 8.110642, 6.606463, .8692867, 8.110642, 6.860536, .8692867, .0254 ANT
GW404, 6, 11.44021, 6.423207, 1.413314, 10.08419, 6.604148, 1.191652, .0254 ANT
GW405, 2, 12.44434, 5.933952, 2.706827, 12.44434, 6.188025, 2.706827, .0254 ANT
GW406, 4, 11.44021, 6.428207, 1.413314, 11.91073, 6.315351, 2.019847, .0254 ANT
GW407, 4, 12.44434, 6.188025, 2.706827, 11.91073, 6.315351, 2.019847, .0254 ANT
GW408, 2, 11.91073, 6.315351, 2.019847, 11.91073, 6.061278, 2.019847, .0254 ANT
GW409, 1, 11.8679, 5.933952, 2.162221, 11.91073, 6.061278, 2.019847, .0254 ANT
GW410, 2, 12.74414, 5.933952, 3.506663, 12.55083, 5.933952, 3.209763, .0254 ANT
GW411, 2, 12.44434, 5.933952, 2.706827, 12.21863, 5.933952, 2.70046, .0254 ANT
GW412, 6, 8.110642, 6.860536, .8692867, 9.348015, 6.699642, 1.071271, .0254 ANT
GW413, 2, 9.353224, 6.411423, .8704442, 9.348015, 6.699642, 1.071271, .0254 ANT
GW414, 4, 9.348015, 6.699642, 1.071271, 10.08419, 6.604148, 1.191652, .0254 ANT
GW415, 2, 10.0865, 6.295673, .8640779, 10.08419, 6.604148, 1.191652, .0254 ANT
GW416, 2, 12.44434, 6.188025, 2.706827, 12.44434, 6.487819, 2.706827, .0254 ANT
GW417, 6, 11.44021, 6.728001, 1.413314, 12.44434, 6.487819, 2.706827, .0254 ANT
GW418, 1, 11.44021, 6.174135, 1.413314, 11.44021, 6.428207, 1.413314, .0254,
GM 0, 0, 0, 0, 180 (ROTATE ABOUT Z AXIS TO HEAD IN PHI=0)
GE
EX 0, 401, 2, 01, 1, 0 (1 VOLT EXCITATION, ANT = TAG 401)
PL3, 2, 0, 4
RP0, 1, 361, 1000, 90, 0, 0, 1 STD. HORIZONTAL PATTERN CUT
PL3, 2, 0, 4
RP0, 1, 361, 1000, 26, 0, 0, 1 HORIZONTAL CUT, ELEVATION = 64 DEG
PL3, 1, 0, 4
RP0, 361, 1, 1000, 0, 0, 1, 0 STD. VERTICAL PATTERN CUT
PL3, 1, 0, 4
RP0, 361, 1, 1000, 0, 45, 1, 0 VERT CUT AT PHI = 45 DEG
XQ
EN

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CM H60 IGUANA DATA CREATED 7/31/87
 CM GREEN'S FUNCTION FOR HELICOPTER
 CM FINAL GW CARDS

*****CM FREE SPACE
 *****CM FREQ = 26.836MHZ

CE
 GW1,3,4.26702,9.397726,.150275,5.867054,9.397726,.150275,.0254,
 GW2,3,5.867054,9.397726,.150275,7.187892,9.397726,.150275,.0254,
 GW3,2,7.187892,9.397726,.150275,8.382183,9.397726,.150275,.0254,
 GW4,1,8.978538,9.397726,.150275,9.575684,9.397726,.150275,.0254,
 GW5,2,4.26702,9.397726,.150275,4.26702,8.229535,.150275,.0254,
 GW6,2,5.867054,9.397726,.150275,5.867054,8.229535,.150275,.0254,
 GW7,2,7.187892,9.397726,.150275,7.187892,8.229535,.150275,.0254,
 GW8,2,8.382183,9.397726,.150275,8.382183,8.229535,.150275,.0254,
 GW9,2,9.575684,9.397726,.150275,9.575684,8.229535,.150275,.0254,
 GW10,2,10.73122,8.229535,.150275,10.73122,9.042603,.150275,.0254,
 GW11,2,11.88755,8.686688,.150275,11.88755,8.229535,.150275,.0254,
 GW12,1,12.53452,8.229535,.2135487,12.53452,8.648724,.2135487,.0254,
 GW13,1,13.18228,8.61076,.2776133,13.18228,8.229535,.2776133,.0254,
 GW14,1,13.94473,8.229535,.3155776,13.94473,8.58545,.3155776,.0254,
 GW15,1,14.70639,8.560141,.3535418,14.70639,8.229535,.3535418,.0254,
 GW16,1,5.409901,9.397726,1.978885,5.867054,9.397726,1.978885,.0254,
 GW17,1,5.867054,9.397726,1.978885,6.298897,9.397726,1.978885,.0254,
 GW18,2,6.298897,9.397726,1.978885,7.187892,9.397726,1.978885,.0254,
 GW19,2,7.187892,9.397726,1.978885,8.229535,9.397726,1.978885,.0254,
 GW20,1,8.229535,9.397726,1.978885,8.978538,9.397726,1.978885,.0254,
 GW21,4,5.409901,9.093222,1.978885,7.187892,9.093222,2.385418,.0254,
 GW22,2,7.187892,9.093222,2.385418,8.229535,9.093222,2.385418,.0254,
 GW23,1,8.229535,9.397726,2.385418,8.978538,9.397726,2.385418,.0254,
 GW24,1,8.978538,9.397726,2.385418,9.575684,9.397726,2.385418,.0254,
 GW25,2,5.409901,9.093222,1.978885,5.409901,8.229535,1.978885,.0254,
 GW26,1,5.409901,9.397726,1.978885,5.409901,9.093222,1.978885,.0254,
 GW27,2,6.298897,8.229535,2.182152,6.298897,9.093222,2.182152,.0254,
 GW28,1,6.298897,9.397726,1.978885,6.298897,9.093222,2.182152,.0254,
 GW29,2,7.187892,9.093222,2.385418,7.187892,8.229535,2.385418,.0254,
 GW30,1,7.187892,9.397726,1.978885,7.187892,9.093222,2.385418,.0254,
 GW31,2,8.229535,9.093222,2.385418,8.229535,8.229535,2.385418,.0254,
 GW32,1,8.229535,9.093222,2.385418,8.229535,9.397726,2.385418,.0254,
 GW33,2,9.575684,9.397726,2.385418,9.575684,8.229535,2.385418,.0254,
 GW34,1,10.73122,8.229535,2.182152,10.73122,8.814026,2.182152,.0254,
 GW35,1,8.229535,9.397726,1.978885,8.229535,9.397726,2.385418,.0254,
 GW36,1,8.978538,9.397726,1.978885,8.978538,9.397726,2.385418,.0254,
 GW37,1,13.94473,8.58545,.3155776,13.94473,8.408283,.9665057,.0254,
 GW38,2,4.648244,9.397726,.7600753,5.867054,9.397726,.7600753,.0254,
 GW39,3,5.867054,9.397726,1.06458,7.187892,9.397726,1.06458,.0254,
 GW40,1,8.978538,9.397726,1.06458,9.575684,9.397726,1.267847,.0254,
 GW41,3,14.70639,8.394837,.9380326,16.05254,8.229535,.9119322,.0254,
 GW42,2,4.838856,8.229535,1.06458,4.838856,9.397726,1.06458,.0254,
 GW43,16,8.229535,8.229535,3.071147,8.229535,16.45907,3.071147,.0254,
 GW44,4,16.50574,8.229535,1.267847,16.67736,10.42197,1.267847,.0254,
 GW45,2,16.67736,10.42197,1.267847,17.45247,10.42197,1.267847,.0254,
 GW46,4,17.45247,10.42197,1.267847,17.62331,8.229535,1.267847,.0254,
 GW47,2,16.67736,10.42197,1.267847,17.06808,9.517155,1.267847,.0254,
 GW48,3,4.26702,7.061345,.150275,5.867054,7.061345,.150275,.0254,
 GW49,3,5.867054,7.061345,.150275,7.187892,7.061345,.150275,.0254,
 GW50,2,7.187892,7.061345,.150275,8.382183,7.061345,.150275,.0254,
 GW51,1,8.382183,7.061345,.150275,8.978538,7.061345,.150275,.0254,
 GW52,1,8.978538,7.061345,.150275,9.575684,7.061345,.150275,.0254,
 GW53,2,4.26702,8.229535,.150275,4.26702,7.061345,.150275,.0254,
 GW54,2,5.867054,8.229535,.150275,5.867054,7.061345,.150275,.0254,
 GW55,2,7.187892,8.229535,.150275,7.187892,7.061345,.150275,.0254,
 GW56,2,8.382183,8.229535,.150275,8.382183,7.061345,.150275,.0254,
 GW57,2,9.575684,8.229535,.150275,9.575684,7.061345,.150275,.0254,
 GW58,2,10.73122,8.229535,.150275,10.73122,7.416468,.150275,.0254,
 GW59,2,11.88755,8.229535,.150275,11.88755,7.772383,.150275,.0254,
 GW60,1,12.53452,8.229535,.2135487,12.53452,7.810347,.2135487,.0254,
 GW61,1,13.18228,8.229535,.2776133,13.18228,7.848311,.2776133,.0254,
 GW62,1,13.94473,8.229535,.3155776,13.94473,7.873621,.3155776,.0254,
 GW63,1,14.70639,8.229535,.3535418,14.70639,7.899721,.3535418,.0254,
 GW64,1,5.409901,7.061345,1.978885,5.867054,7.061345,1.978885,.0254,
 GW65,1,5.867054,7.061345,1.978885,6.298897,7.061345,1.978885,.0254,
 GW66,2,6.298897,7.061345,1.978885,7.187892,7.061345,1.978885,.0254,

GW67,2,7.187892,7.061345,1.978885,8.229535,7.061345,1.978885,.0254,
 GW68,1,8.229535,7.061345,1.978885,8.978538,7.061345,1.978885,.0254,
 GW69,4,5.409901,7.36585,1.978885,7.187892,7.36585,2.385418,.0254,
 GW70,2,7.187892,7.36585,2.385418,8.229535,7.36585,2.385418,.0254,
 GW71,1,8.229535,7.061345,2.385418,8.978538,7.061345,2.385418,.0254,
 GW72,1,8.978538,7.061345,2.385418,9.575684,7.061345,2.385418,.0254,
 GW73,2,5.409901,8.229535,1.978885,5.409901,7.36585,1.978885,.0254,
 GW74,1,5.409901,7.061345,1.978885,5.409901,7.36585,1.978885,.0254,
 GW75,2,6.298897,8.229535,2.182152,6.298897,7.36585,2.182152,.0254,
 GW76,1,6.298897,7.061345,1.978885,6.298897,7.36585,2.182152,.0254,
 GW77,2,7.187892,8.229535,2.385418,7.187892,7.36585,2.385418,.0254,
 GW78,1,7.187892,7.061345,1.978885,7.187892,7.36585,2.385418,.0254,
 GW79,2,8.229535,8.229535,2.385418,8.229535,7.36585,2.385418,.0254,
 GW80,1,8.229535,7.36585,2.385418,8.229535,7.061345,2.385418,.0254,
 GW81,2,9.575684,8.229535,2.385418,9.575684,7.061345,2.385418,.0254,
 GW82,1,10.73122,8.229535,2.182152,10.73122,7.645044,2.182152,.0254,
 GW83,1,8.229535,7.061345,1.978885,8.229535,7.061345,2.385418,.0254,
 GW84,1,8.978538,7.061345,1.978885,8.978538,7.061345,2.385418,.0254,
 GW85,2,4.648244,7.061345,.7600753,5.867054,7.061345,.7600753,.0254,
 GW86,3,5.867054,7.061345,1.06458,7.187892,7.061345,1.06458,.0254,
 GW87,1,8.978538,7.061345,1.06458,9.575684,7.061345,1.267847,.0254,
 GW88,3,16.05254,8.229535,.9119322,14.70639,8.064233,9.380326,.0254,
 GW89,2,4.838856,8.229535,1.06458,4.838856,7.061345,1.06458,.0254,
 GW90,16,8.229535,8.229535,3.071147,8.229535,0.,3.071147,.0254,
 GW91,4,16.50574,8.229535,1.267847,16.67736,6.037892,1.267847,.0254,
 GW92,2,16.67736,6.037892,1.267847,17.45247,6.037892,1.267847,.0254,
 GW93,4,17.62331,8.229535,1.267847,17.45247,6.037892,1.267847,.0254,
 GW94,3,4.26702,8.229535,.150275,5.867054,8.229535,.150275,.0254,
 GW95,3,5.867054,8.229535,.150275,7.187892,8.229535,.150275,.0254,
 GW96,4,5.409901,8.229535,1.978885,7.187892,8.229535,2.385418,.0254,
 GW97,2,7.187892,8.229535,2.385418,8.229535,8.229535,2.385418,.0254,
 GW98,3,8.229535,8.229535,2.385418,9.575684,8.229535,2.385418,.0254,
 GW99,1,16.05254,8.229535,.9119322,16.05254,8.229535,1.217228,.0254,
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 GW101,3,16.05254,8.229535,.9119322,17.39869,8.229535,.9119322,.0254,
 GW102,2,16.05254,8.229535,1.217228,16.73747,8.229535,1.941712,.0254,
 GW103,4,16.73747,8.229535,1.941712,18.26237,8.229535,3.553609,.0254,
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 GW105,2,17.60195,8.229535,1.267847,18.05436,8.229535,1.949621,.0254,
 GW106,3,18.05436,8.229535,1.949621,18.92279,8.229535,3.325033,.0254,
 GW107,1,18.26237,8.229535,3.553609,18.92279,8.229535,3.325033,.0254,
 GW108,3,16.73747,8.229535,1.941712,18.05436,8.229535,1.949621,.0254,
 GW109,3,16.73747,8.229535,1.941712,18.1469,8.229535,2.833871,.0254,
 GW110,1,16.50574,8.229535,1.267847,16.05254,8.229535,1.217228,.0254,
 GW111,2,16.50574,8.229535,1.267847,17.62331,8.229535,1.267847,.0254,
 GW112,1,8.229535,8.229535,2.385418,8.229535,8.229535,3.071147,.0254,
 GW113,16,8.229535,8.229535,3.071147,0.,8.229535,3.071147,.0254,
 GW114,16,8.229535,8.229535,3.071147,16.45907,8.229535,3.071147,.0254,
 GW115,2,11.88755,8.686688,.150275,11.68032,8.750752,.150275,.0254,
 GW117,2,18.92279,8.229535,3.325033,18.1469,8.229535,2.833871,.0254,
 GW118,1,18.26237,8.229535,3.553609,18.1469,8.229535,2.833871,.0254,
 GW119,2,18.05436,8.229535,1.949621,18.1469,8.229535,2.833871,.0254,
 GW120,2,13.94473,8.229535,1.623761,14.70639,8.229535,1.521732,.0254,
 GW121,2,13.18228,8.229535,1.724999,13.94473,8.229535,1.623761,.0254,
 GW122,1,12.53452,8.229535,1.852337,13.18228,8.229535,1.724999,.0254,
 GW123,1,11.88755,8.229535,1.978885,12.53452,8.229535,1.852337,.0254,
 GW124,3,11.88755,8.686688,.150275,12.53452,8.648724,.2135487,.0254,
 GW125,1,13.18228,8.61076,.2776133,12.53452,8.648724,.2135487,.0254,
 GW126,2,13.18228,8.61076,.2776133,13.94473,8.58545,.3155776,.0254,
 GW127,2,14.70639,8.560141,.3535418,13.94473,8.58545,.3155776,.0254,
 GW128,2,14.70639,7.899721,.3535418,13.94473,7.873621,.3155776,.0254,
 GW129,2,13.18228,7.848311,.2776133,13.94473,7.873621,.3155776,.0254,
 GW130,1,13.18228,7.848311,.2776133,12.53452,7.810347,.2135487,.0254,
 GW131,1,11.88755,7.772383,.150275,12.53452,7.810347,.2135487,.0254,
 GW132,1,14.70639,8.064233,.9380326,13.95818,8.051578,.9688785,.0254,
 GW133,2,13.18228,8.038923,1.001306,13.95818,8.051578,.9688785,.0254,
 GW134,1,13.18228,8.038923,1.001306,12.54559,8.019941,1.032152,.0254,
 GW135,1,11.88755,8.000959,1.06458,12.54559,8.019941,1.032152,.0254,
 GW136,2,14.70639,8.394837,.9380326,13.94473,8.408283,.9665057,.0254,
 GW137,2,13.18228,8.420147,1.001306,13.94473,8.408283,.9665057,.0254,
 GW138,1,13.18228,8.420147,1.001306,12.52345,8.43913,1.033734,.0254,
 GW139,4,11.88755,8.458112,1.06458,12.52345,8.43913,1.033734,.0254,

GW140,3,14.70639,8.560141,.3535418,16.05254,8.229535,.632737,.0254,
GW141,3,17.39869,8.229535,.9119322,16.05254,8.229535,.632737,.0254,
GW142,3,17.39869,8.229535,.9119322,16.05254,8.229535,1.217228,.0254,
GW143,3,14.70639,8.229535,1.521732,16.05254,8.229535,1.217228,.0254,
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GW145,1,16.50574,8.229535,1.267847,17.00876,8.229535,1.489305,.0254,
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GW147,1,17.39869,8.229535,.9119322,17.00876,8.229535,1.489305,.0254,
GW148,1,16.73747,8.229535,1.941712,17.00876,8.229535,1.489305,.0254,
GW149,3,17.62331,8.229535,1.267847,17.06808,9.517155,1.267847,.0254,
GW150,2,17.45247,10.42197,1.267847,17.06808,9.517155,1.267847,.0254,
GW151,3,16.50574,8.229535,1.267847,17.06808,9.517155,1.267847,.0254,
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GW153,2,17.45247,6.037892,1.267847,17.06254,6.929261,1.267847,.0254,
GW154,2,16.67736,6.037892,1.267847,17.06254,6.929261,1.267847,.0254,
GW155,2,10.73122,8.814026,2.182152,10.73122,8.929501,1.1587,.0254,
GW156,6,11.88755,8.458112,1.06458,10.73122,8.929501,1.1587,.0254,
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GW159,3,11.88755,8.000959,1.06458,10.73122,7.531943,1.175309,.0254,
GW160,2,10.73122,7.416468,1.50275,10.73122,7.531943,1.175309,.0254,
GW161,3,9.575684,7.061345,1.267847,10.73122,7.531943,1.175309,.0254,
GW162,2,7.187892,9.397726,1.978885,7.187892,9.397726,1.06458,.0254,
GW163,2,5.867054,9.397726,1.978885,5.867054,9.397726,1.06458,.0254,
GW164,2,7.187892,7.061345,1.978885,7.187892,7.061345,1.06458,.0254,
GW165,2,5.867054,7.061345,1.978885,5.867054,7.061345,1.06458,.0254,
GW166,2,7.187892,7.061345,1.50275,7.187892,7.061345,1.06458,.0254,
GW167,1,5.867054,9.397726,7.600753,5.867054,9.397726,1.06458,.0254,
GW168,1,5.867054,7.061345,7.600753,5.867054,7.061345,1.06458,.0254,
GW169,1,5.867054,7.061345,1.50275,5.867054,7.061345,7.600753,.0254,
GW170,2,7.187892,9.397726,1.50275,7.187892,9.397726,1.06458,.0254,
GW171,1,5.867054,9.397726,1.50275,5.867054,9.397726,7.600753,.0254,
GW172,2,5.409901,7.061345,1.978885,4.838856,7.061345,1.06458,.0254,
GW173,1,4.648244,7.061345,7.600753,4.838856,7.061345,1.06458,.0254,
GW174,1,4.26702,7.061345,1.50275,4.648244,7.061345,7.600753,.0254,
GW175,2,5.409901,9.397726,1.978885,4.838856,9.397726,1.06458,.0254,
GW176,1,4.648244,9.397726,7.600753,4.838856,9.397726,1.06458,.0254,
GW177,1,4.26702,9.397726,1.50275,4.648244,9.397726,7.600753,.0254,
GW178,1,14.70639,8.229535,1.521732,14.70639,8.064233,.9380326,.0254,
GW179,1,14.70639,7.899721,.3535418,14.70639,8.064233,.9380326,.0254,
GW180,1,13.94473,8.229535,1.623761,13.95818,8.051578,.9688785,.0254,
GW181,1,13.94473,7.873621,3.155776,13.95818,8.051578,.9688785,.0254,
GW182,1,13.18228,8.229535,1.724999,13.18228,8.038923,1.001306,.0254,
GW183,1,13.18228,7.848311,2.776133,13.18228,8.038923,1.001306,.0254,
GW184,2,12.53452,8.229535,1.852337,12.54559,8.019941,1.032152,.0254,
GW185,2,12.53452,7.810347,2.135487,12.54559,8.019941,1.032152,.0254,
GW186,1,13.94473,8.229535,1.623761,13.94473,8.408283,.9665057,.0254,
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GW188,1,14.70639,8.560141,.3535418,14.70639,8.394837,.9380326,.0254,
GW189,1,13.18228,8.61076,2.776133,13.18228,8.420147,1.001306,.0254,
GW190,1,13.18228,8.229535,1.724999,13.18228,8.420147,1.001306,.0254,
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GW192,2,12.53452,8.648724,2.135487,12.52345,8.43913,1.033734,.0254,
GW193,3,11.88755,8.5724,6.0743,11.88755,8.458112,1.06458,.0254,
GW194,6,11.88755,8.229535,1.978885,11.88755,8.458112,1.06458,.0254,
GW195,2,11.88755,8.229535,1.978885,11.88755,8.000959,1.06458,.0254,
GW196,2,11.88755,7.772383,1.50275,11.88755,8.000959,1.06458,.0254,
GW197,4,10.73122,8.229535,1.50275,11.88755,8.229535,1.50275,.0254,
GW198,2,9.575684,8.229535,1.50275,10.73122,8.229535,1.50275,.0254,
GW199,2,8.382183,8.229535,1.50275,9.575684,8.229535,1.50275,.0254,
GW200,2,7.187892,8.229535,1.50275,8.382183,8.229535,1.50275,.0254,
GW201,2,10.73122,8.98605,6.54488,10.73122,8.929501,1.1587,.0254,
GW202,2,8.978538,9.397726,1.978885,8.978538,9.397726,1.06458,.0254,
GW203,2,9.575684,9.397726,2.385418,9.575684,9.397726,1.267847,.0254,
GW204,2,8.978538,9.397726,1.50275,8.978538,9.397726,1.06458,.0254,
GW205,1,8.382183,9.397726,1.50275,8.978538,9.397726,1.50275,.0254,
GW206,2,9.575684,9.397726,1.50275,10.73122,9.042603,1.50275,.0254,
GW207,2,9.575684,9.397726,1.50275,9.575684,9.397726,1.267847,.0254,
GW208,2,9.575684,7.061345,2.385418,9.575684,7.061345,1.267847,.0254,
GW209,2,9.575684,7.061345,1.50275,9.575684,7.061345,1.267847,.0254,
GW210,3,9.575684,9.397726,2.385418,10.73122,8.814026,2.182152,.0254,
GW211,3,9.575684,7.061345,2.385418,10.73122,7.645044,2.182152,.0254,

GW212,3,11.88755,8.229535,1.978885,10.73122,7.645044,2.182152,.0254,
 GW213,3,11.88755,8.229535,1.978885,10.73122,8.814026,2.182152,.0254,
 GW214,2,8.978538,7.061345,1.978885,8.978538,7.061345,1.06458,.0254,
 GW215,2,8.978538,7.061345,.150275,8.978538,7.061345,1.06458,.0254,
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 GW217,2,9.575684,7.061345,.150275,10.73122,7.416468,.150275,.0254,
 GW218,2,9.575684,8.229535,2.385418,10.73122,8.229535,2.182152,.0254,
 GW219,2,10.73122,9.042603,.150275,11.68032,8.750752,.150275,.0254,
 GW220,2,11.88755,8.5724,.60743,11.88755,8.686688,.150275,.0254
 GW221,2,10.73122,8.98605,.654488,10.73122,9.042603,.150275,.0254
 GW222,3,11.88755,8.5724,.60743,11.3094,8.77923,.630959,.0254
 GW223,3,11.3094,8.77923,.630959,10.73122,8.98605,.654488,.0254
 *****GM 0,0,0,180 (MOVE UP @ GND) (ROTATE ABOUT Z AXIS)
 *****GE (GEI FOR GROUND *** AND ADD GN AND GM CARDS)
 *****FR 0,0,0,26.836,0

WG

*****ORIGINAL LONGWIRE ANTENNA*****

NX

CM ORIGINAL LONGWIRE ANTENNA SPACED 18" FROM A/C

CM STANDARD RADIATION PATTERNS

CE

GF

GW401,1,11.88755,8.458112,1.064580,11.88755,8.908386,1.064580,.0254 ANT
 GW402,8,11.88755,8.908386,1.064580,10.73122,9.41774,.8175375,.0254 ANT
 GW403,4,10.73122,9.41774,.8175375,10.73122,9.324411,1.651959,.0254 ANT
 GW404,8,10.73122,9.324411,1.651959,12.53452,8.62981,1.852062,.0254 ANT
 GW405,14,12.53452,8.62981,1.852062,16.05254,8.62981,1.216953,.0254 ANT
 GM 0,0,0,0,180 (ROTATE ABOUT Z AXIS TO HEAD IN PHI=0)

GE

EX 0,402,2,01, 1,0 (1 VOLT EXCITATION, ANT = 402,2)

PL3, 2, 0, 4

RP0, 1, 361, 1000, 90, 0, 0, 1 STD. HORIZONTAL PATTERN CUT

PL3, 2, 0, 4

RP0, 1, 361, 1000, 26, 0, 0, 1 HORIZONTAL CUT, ELEVATION = 64 DEG

PL3, 1, 0, 4

RP0, 361, 1, 1000, 0, 0, 1, 0 STD. VERTICAL PATTERN CUT

PL3, 1, 0, 4

RP0, 361, 1, 1000, 0, 45, 1, 0 VERT CUT AT PHI = 45 DEG

XQ

*****COLLINS 437R-2 ANTENNA*****

NX

CM ESTIMATED ORIGINAL PLACEMENT OF 437R-2 ANT

CM STANDARD RADIATION PATTERNS

CE

GF

GW401,3,11.3094,8.77923,.630959,11.3094,8.901028,0,.0254 ANT
 GW402,8,11.88755,8.529294,1.978885,11.88043,8.901028,0,.0254 ANT
 GW403,16,11.88755,8.529294,1.978885,16.05254,8.529294,1.217228,.0254 ANT
 GW404,2,11.3094,8.901028,0,.11.88043,8.901028,0,.0254 ANT
 GM 0,0,0,0,180 (ROTATE ABOUT Z AXIS TO HEAD IN PHI=0)

GE

EX 0,401,2,01, 1,0 (1 VOLT EXCITATION, ANT = 401,2)

PL3, 2, 0, 4

RP0, 1, 361, 1000, 90, 0, 0, 1 STD. HORIZONTAL PATTERN CUT

PL3, 2, 0, 4

RP0, 1, 361, 1000, 26, 0, 0, 1 HORIZONTAL CUT, ELEVATION = 64 DEG

PL3, 1, 0, 4

RP0, 361, 1, 1000, 0, 0, 1, 0 STD. VERTICAL PATTERN CUT

PL3, 1, 0, 4

RP0, 361, 1, 1000, 0, 45, 1, 0 VERT CUT AT PHI = 45 DEG

XQ

*****PROPOSED CG COLLINS 437R-2 ANT INSTALLATION*****

NX

CM PROPOSED CG LOCATION OF COLLINS 437R-2 ANT

CM STANDARD RADIATION PATTERNS

CE

GF

GW401,3,11.3094,8.77923,.630959,11.31,9.3,.63,.0254
 GW402,20,11.31,9.3,.63,16.0,8.5,0.3,.0254
 GM 0,0,0,0,180 (ROTATE ABOUT Z AXIS TO HEAD IN PHI=0)

GE

EX 0,401,2,01, 1,0 (1 VOLT EXCITATION, ANT = 401,2)

FILE: H60 DATA A1

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PL3, 2, 0, 4
RP0, 1, 361, 1000, 90, 0, 0, 1     STD. HORIZONTAL PATTERN CUT
PL3, 2, 0, 4
RP0, 1, 361, 1000, 26, 0, 0, 1     HORIZONTAL CUT, ELEVATION = 64 DEG
PL3, 1, 0, 4
RP0, 361, 1, 1000, 0, 0, 1, 0     STD. VERTICAL PATTERN CUT
PL3, 1, 0, 4
RP0, 361, 1, 1000, 0, 45, 1, 0     VERT CUT AT PHI = 45 DEG
XQ
*****ARMY-TYPE TUBE ANTENNA*****
NX
CM TUBE ANTENNA
CM STANDARD RADIATION PATTERNS
CE
GF
GW401,1,11.88755,8.458112,1.064580,11.88755,8.686688,1.064580,.0254     ANT
GW402,1,16.05254,8.229535,.9119322,16.05254,8.458112,.9119322,.0254     ANT
GW403,12,11.88755,8.686688,1.064580,14.70639,8.623414,.9377575,.0254     ANT
GW404,12,14.70639,8.623414,.9377575,16.05254,8.458112,.9119322,.0254     ANT
GM 0,0,0,0,180                     (RCTATE ABOUT Z AXIS TO HEAD IN PHI=0)
GE
EX 0,403,2,01, 1,0                     (1 VOLT EXCITATION, ANT = 403,2)
PL3, 2, 0, 4
RP0, 1, 361, 1000, 90, 0, 0, 1     STD. HORIZONTAL PATTERN CUT
PL3, 2, 0, 4
RP0, 1, 361, 1000, 26, 0, 0, 1     HORIZONTAL CUT, ELEVATION = 64 DEG
PL3, 1, 0, 4
RP0, 361, 1, 1000, 0, 0, 1, 0     STD. VERTICAL PATTERN CUT
PL3, 1, 0, 4
RP0, 361, 1, 1000, 0, 45, 1, 0     VERT CUT AT PHI = 45 DEG
XQ
EN

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